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Real Fairy Tales

Some minds a few centuries hence will find it necessary to solve a problem that will stagger even the inventive brain of that (presumably) highly advanced era—that of devising a new set of fairy tales. We have about caught up to the old set. We no longer need to rub Aladdin's lamp to rush along over the land with the speed of the hurricane, to fly through the air, to plunge under and explore the sea, to talk to the hither side of the earth or to summon a whole operatic troupe for our private benefit or even listen to a departed singer. Last week Mr. Frank A. Vanderlip, president of the National City Bank of New York, in an address before the representatives of electrical interests at Association Island, added another chapter to our twentieth-century real fairy tales. Two billion dollars, he stated, could be invested with profit in the electrical industry of the United States alone in the next five years—an amount equal to \$8,000,000 of fresh capital per week. And lest it be thought that he was romancing, he promptly pointed out that no more was needed than a grasp of present-day statistics, compared with those of five or ten years ago, to give the basis for such an estimate. Moreover, going a step farther, he showed that past statistics indicated that the railroads will likely need \$4,000,000,000 in the next five years, and the States and municipalities \$1,500,000,000 more, so that these three fields alone will absorb between \$7,000,000,000 and \$8,000,000,000 between now and the end of 1918. When to this sum is added the needs of industry in general the figures are truly staggering. After a few moments' reflection of these estimates one cannot but feel that the day of romancing with figures is past.

Mr. Vanderlip on Regulation The figures quoted by Mr. Vanderlip, as above noted, served merely as an introduction to a discussion of the financial situation which the electrical industry faces, and the effect on that industry of public-utility regulation. "The newly organized public service commissions," he said, "recognizing the monopoly character of the [electrical] business, are guarding it from useless and venal competition, as they are also guarding the investor from too free capital issues by the optimistic developer or the enthusiastic promoter. We are a long way from having either uniform or satisfactory administration of public service commissions, it is true, . . . but I think no one will deny that the securities of public service corporations are sounder and their future more secure, on the whole, because of the tendency to place the affairs of these corporations under the control of public-service commissions. I believe the highest duty that you men who are managing great public-service corporations owe to the business in which you are engaged lies in the clear recognition by you of the true public-service character of this business and in meeting honestly, intelligently, and freely the proper demands that the public makes upon you." While these views, even as coming from high financial authority, are not new, they are worthy of repetition if for no other reason than that they indicate the optimism of financial interests in the face of regulation that is still chaotic, uncertain and sometimes unduly onerous.

The Harlem River Tubes

The successful sinking of a four-track section of the Lexington Avenue subway under the Harlem River, New York, again calls attention to a method that should become increasingly more important in subaqueous tunneling work because of its decided advantages, where applicable, over the shield system. It has been used successfully in a number of tunnels, notably that of the Michigan Central Railroad at Detroit. Until recently no other method of subaqueous tunneling was used to any great extent except the shield system, which is not only a slow process, but involves the use of compressed air, constantly subjecting the workers to great danger. In the method used last week in the Harlem River four sectional steel shells were built and connected together on shore, launched and then sunk to a bed carefully prepared in advance by divers. The methods have been so well developed that the work proceeds with expedition and certainty, at the same time eliminating the dangerous conditions inevitably connected with compressed-air work. By this method the tunnel may have practically unlimited dimensions, including great width; moreover, there is very little obstruction to navigation, and finally the cost is considerably less than that of shield tunneling. The important engineering feature of the method is the high degree of skill with which a very simple and inexpensive pneumatic-control system has been applied to the sinking of the enormous steel shells. By it a mass weighing many thousands of tons can be rapidly handled solely by the manipulation of ordinary inlet and outlet valves, regulating its buoyancy with such delicacy that all of the movements are regular and deliberate. Plunging and violent displacement are eliminated and the final movements of many feet or the fraction of an inch are quickly and certainly accomplished by ordinary hoisting engines exerting a stress of only a few thousand pounds.

Surge Tanks on Penstocks

In the design of high-head plants with long conduits precautions must be taken to safeguard against damage by water hammer. Various mechanical appliances for absorbing shocks due to such surges have been proposed, but few are of any practical value. Those which really are worth while offer mathematical problems of such difficulty that few engineers are able to design them. One device which on account of its apparent simplicity has been widely applied is the simple surge tank; but engineers have learned in many cases that it fails to relieve the surges and might better have been omitted entirely. Surge tanks have, therefore, been the subject of very careful analysis, resulting in complicated formulae, some of which are not worth the paper on which they are written. Many designers hold that the only way of determining the proper dimensions of a surge tank and the effect on the surges is to figure out laboriously what takes place in the tank. The pressure results when plotted will show the wave action in the chamber, the draft velocity, the conduit velocity, the hydraulic gradient, etc. Should the waves show a tendency to increase, a new dimension of tank must be assumed and the calculations repeated. As this method requires a great amount of work, sev-

eral types of standpipes have been developed in which this wave action is resisted or "damped." Among these types are the differential tanks, the pressure chamber with an air cushion and the double tank. One of the simpler types is that developed by Prof. F. W. Durand, in which a funnel-shaped chamber is used to dampen the oscillations with a force varying as the square of the velocity. A surge chamber of this type and of large size has been built for the San Francisco power station, as described on page 299. The funnel was first designed as an elliptic paraboloid, but later, for construction reasons, the shape was changed to the frustum of a cone, with a cylindrical section above it, so designed as to have the same cubical capacity between the extreme ranges of water level as the paraboloid. Hydraulic engineers will be much interested in the operation of the tank, and the engineers of the Los Angeles aqueduct can be of service to the profession by giving full publicity to the results.

Opportunities in Engineering

In a recent editorial the New York "Times" commented as follows on engineering work:

"There is a dearth of engineers and there is a mighty good livelihood awaiting those who enter this profession. Other professions are overcrowded. We should think that young men about to enter college would consider seriously the opportunities of engineering." As was to be expected, these views were promptly characterized as erroneous by readers of the paper. Unfortunately there is still much misconception as to the opportunities in engineering work, and especially as to the monetary returns, though it is less pronounced than it was ten years ago. Then the air was full of tales of the remarkable future in engineering and technical schools were swamped with young men who had picked an engineering career not because they had an aptitude for the work but because in very many cases they had no special tastes for any line and chose the one apparently offering the most alluring financial inducements. They were caught by the lure of gold and became square pegs in round holes. The situation is changing, not only because the truth as to engineering prospects is better known but because the "business" courses have come into prominence and are believed to be a more direct route to captaincies in industry and commerce. The truth is that an engineering career must be selected as one would choose law, or medicine, or the ministry, or teaching—not for financial reasons but because of aptitude and liking for the work. To those who select it for these reasons there are good opportunities—but the boy whose eye is covered by the dollar and who has no sincere interest in things mechanical will be sure to fall into the ranks of the discontented if a kind Providence does not guide him into some non-technical allied line. If his chief aim in life is a monetary reward he must select some other profession than engineering. Yet, in one respect, the "Times" editorial was correct, for even the misfit can, and generally does, earn a "mighty good livelihood." That will be disputed, of course to the extent that there is difference of opinion as to what constitutes a "mighty good livelihood." If the returns of men in financial life are taken as the standard, the statement is

wrong; but for men of sobriety, reliability and application, with a taste for engineering work, the financial returns and the opportunity to branch out in the often more remunerative fields of contracting, manufacturing and business fully justify the statement made in the "Times."

Railway-Valuation Maps

The objections raised by the railroads to the Interstate Commerce Commission's tentative draft of specifications for maps and profiles for the railroad valuation, as outlined on page 292, prepared as they were by high engineering and right-of-way officials of the railroads, leave little room for argument. It is not strange that the commission, foreseeing the vast amount of work necessary in picking the information off the best of maps, should desire uniformity and great durability. Nevertheless, the valuation at best will be very expensive to the railroads, and the expense should be minimized wherever possible. In drawings this would be accomplished by accepting blueprints or negatives of existing maps. As to standards in drafting, it is doubtful whether rigid enforcement is feasible. On some small roads real draftsmanship is rare. Such improvements as are made are guided by rough sketch plans, or they even proceed without any plans at all. From these roads the commission will probably have to take what it can get in the way of draftsmanship and adherence to standards. Other roads, large and progressive, probably have on hand maps and profiles containing just the information needed, though naturally no two roads will keep it in exactly the same shape. With regard to the supplying of tracings, the difficulty of keeping up to date duplicate tracings, one in the chief engineer's office and one on file with the commission, seems worthy of serious thought. The railroad office has plenty of trouble keeping its own maps up to date. Most of the ordinary changes could not be described by letter, and many of them could not be clearly indicated on blueprints for transcribing to the duplicate tracings. The only sure way would be to send the duplicates to the railroad for each correction, even though this would be courting their damage or loss. Even disregarding the difference in cost, it would seem that a succession of prints on good durable paper or cloth, carefully made to minimize the distortion, would furnish a better record of any railroad active in improvement work than tracings requiring constant revision.

Will-o'-the-Wisp in Garbage Disposal Again

Returning from the non-moisture laden atmosphere of Colorado, Dr. Willis O. Nance, chairman of the health committee of the Chicago City Council, brings with him the idea that garbage in Chicago may yet yield an income to the city by disposing of it to hogs in the outlying districts. Denver's garbage, collected tri-weekly in metal boxes and sterilized, is fed by the Hog Growers' Association at a farm 3 miles from the city limits. About seventy-five hogs are required per ton of garbage. For the 2,250,000 population of Chicago the size of farm necessary to care for the required number of hogs rather staggers one, to say nothing of the problem of keeping the animals free from cholera, a problem the Iowa farmer with all the serums extant finds almost insurmountable.

No doubt the existing reduction plant which the city has just bargained to buy does look

like a white elephant to the officials about to undertake its operation, but in looking around for alternatives it would seem rather nonsensical even to propose hog-feeding which has recently been condemned so severely by the courts in Los Angeles. In some of the smaller New England towns garbage is successfully fed to hogs, but few cities of more than 50,000 population have found it a satisfactory method. Denver's is an isolated case because of the particularly favorable climatic conditions; the brilliant sterilizing sunshine and the dry atmosphere take up the moisture-laden odors with avidity. Sparsely settled districts around Chicago are not so plentiful as in the environs of Denver.

As the Engineering Record has often repeated, Chicago can only hope for a reasonable solution of this troublesome problem by an intensive study of the local situation. The success of the new percolating plant at Columbus, Ohio, for example, as reported in this journal Aug. 23, page 221, does not necessarily augur success for the method in Chicago. The income at Columbus for 1912 was quite materially increased by the percolating plant which cost \$20,000, but recovered grease to the value of nearly \$17,000. Whether there is sufficient grease in the garbage of Chicago, without the rich hotel wastes now sold to private scavengers, to make it pay to build additional means for its extraction is clearly a local problem to be solved only after close study. The committee recently appointed to solve this vexing question, involving public health as well as intricate engineering details, has in hand a problem of no mean proportions.

Diesel-Electric Drive for Ships

The propulsion of ships has been the subject of interesting experimentation in the last decade. From the triple-expansion steam engine to the steam turbine was a notable step, but following it closely were the application of Diesel engines, then the use of the electric drive with current supplied by turbine-driven generators and now the electric drive taking current from Diesel-engine sets. A ship, the Tynemount, with the last type of propulsion, is now being built for a Canadian vessel which will ply on the Great Lakes. The Diesel-engine drive has very special advantages for a vessel in this service, since the short navigation season demands the utmost carrying capacity, and designers have already gone to the limits in hull design imposed by the necessities of lock navigation. The possibilities of using a producer-gas plant and engine were also investigated, but the idea was abandoned owing to its doubtful reliability, uncertain reversing and high speeds.

While the use of direct Diesel-engine drive is apparently working out satisfactorily, judging by recent reports—in the Christian X of the Hamburg-American fleet, in the Monte Penedo and a number of other vessels—there are objections to it of the character that led to the suggestion of electric drive in connection with the steam turbine. In a word, the requirements of ship propulsion necessitate changes in both the Diesel engine and the steam turbine which deprive them of the advantages which are their chief recommendation. In discussing the matter some time ago before the Institution of Naval Architects, in England, Messrs. John Reid and H. A. Mavor pointed out that in order to get the low-propeller speeds desirable for slow-speed cargo vessels, important advantages of the normal Diesel engine, such as high speed, low weight and moderate over-all dimensions, have been

sacrificed, while the necessity for fitting a reversing gear on the engine itself required the use of compressed air—an addition of a troublesome and expensive nature. Moreover, the Diesel engine is a far more delicate piece of apparatus than the steam engine, and, therefore, not well fitted to take the latter's place direct on the propeller shaft. The governor action in a seaway tends to interfere with uniform operation—a factor essential for good performance—and the periodic interference inevitably leads to trouble.

In the new design the aim is to put the Diesel engine back to its normal work—running continuously at high speed—by removing it from the direct influence of the propeller and from the uneven loading and vibration incidental to the direct drive. In the Canadian ship there are two 300-hp Diesel electric units. Contrary to expectation, alternating current is used, the difficulties as to speed regulation being overcome by the use of more than one frequency applied to each motor. The currents of different frequency will be carried in independent circuits, the magnetic systems being entirely independent but operating upon a common rotor, so that their mechanical effects can be superposed and the power transmitted in the separate circuits combined to produce the required mechanical effect.

With the Jupiter of the U. S. Navy in commission, in which electric motors on the shafts take current from turbo-generator sets, the relative merits of the two methods can be compared on a practical basis; moreover, comparison will be possible between the direct Diesel and the Diesel-electric drive. The results will certainly be worthy of careful study.

Erroneous Statements Regarding the Hetch Hetchy Project

The passage by the House of Representatives of the Raker bill granting certain rights-of-way in the Yosemite National Park to San Francisco has served to give the campaign against the measure a rapid turn. The remarkable vote of 183 to 43 in favor of the measure shows that the House was appreciative of the technical and other evidence in favor of the bill and of the weakness of the objections of the "nature lovers." It is apparent, however, that the destructive campaign will be waged now with redoubled energy and that Senators and the President will have to withstand clamors compared with which the protests to the House were but the first mutterings of a storm.

Undoubtedly the opponents of the Hetch Hetchy bill are sincere, but they have allowed their enthusiasm and almost hysterical excitement to carry them into the most exaggerated statements. For example, an open letter recently sent out by Mr. Robert Underwood Johnson, of New York, and quoted in the New York "Evening Sun," says that San Francisco is trying "to obtain from the Government the gift of the wonderful Hetch Hetchy valley" and that the city is "endeavoring to rush through a drastic measure that would turn over to the city 500 sq. miles—half your national park." In other statements the claim has been made that the use of Hetch Hetchy for the water supply of San Francisco will doom to aridness forever thousands of acres of land and that the beauty of the park and its accessibility to tourists will be destroyed. Were it not that the matter is thus misrepresented the country over and printed in newspapers which do not inform themselves as to the facts the ravings would deserve to be left unnoticed. Under the circumstances, however,

it is well to consider some of the facts bearing on the case.

The articles, editorials and letters opposing the Raker bill do not take into account that the greater part of the land required for the development, including the most important of all, the floor of the Hetch Hetchy valley, is owned by the city of San Francisco, and while it is surrounded by the park, it is not part of the park for the reason that title to it has been granted by the Government to ranchers while it was part of the public domain and before the boundaries of the Yosemite National Park had been extended 15 miles to include it. These titles were long ago acquired by the city of San Francisco with the object of utilizing the valley for water supply purposes. In a similar way the city long ago filed on and acquired title to the necessary water rights. It has spent many hundreds of thousands of dollars in acquiring the needed lands.

It has been feared by some that the use of the water in San Francisco would reduce the area of land in the San Joaquin valley that could ultimately be irrigated. It must be remembered that the city of San Francisco cannot interfere with any existing irrigation right, and that no act of Congress would change its position in this respect. The construction of a great reservoir on a wonderful, natural site will serve to permit flood waters now going uselessly down the river to be held and made available when needed. The flows from melting snow in spring, in excess of irrigation requirements, will be stored to furnish water to San Francisco all the year round, and this will be done without taking any water to which irrigators have just right, or which they could use without the construction of a great storage reservoir for which there are no opportunities below the boundaries of the national park. The only way in which more land could ultimately be irrigated than under the proposed plan would be to allow the construction of the Hetch Hetchy dam for irrigation purposes alone instead of for water supply. In other words, the valley on irrigation considerations alone would eventually be turned into a reservoir.

There are those who believe that the Hetch Hetchy dam must ultimately be built in any event. The water now going uselessly to waste that can be conserved and made available by it will have so great a value for water supply, for water power and for irrigation, and the advantages of its construction from every standpoint—even from the standpoint of the beauty and usefulness of the park—are so great that they believe that it is bound to be built. As the city of San Francisco legally filed on the rights to build and use this reservoir twelve years ago, and has the undisputed first right to it, the question as to who shall have the reservoir should be easily settled.

It has also been frequently and erroneously alleged that visitors would be excluded from that part of the park near and above the waterworks. Instead of this it is proposed to welcome them, giving them good roads where now there are only bad trails, and many added facilities that will come with and grow out of the construction work, which will make accessible to visitors interesting regions now reached with difficulty, and for that reason seldom visited.

The streams and lakes of the Yosemite Park are large elements in its beauty and attractiveness. They have a value that cannot be easily realized by those who only know climates of more abundant rainfall. Adding a new lake, larger and more beautiful than any natural lake in the park, will add to its beauty. It is only necessary to contemplate the reverse

proposition to realize this. What, for example, would be said if it were proposed to drain Lake Tahoe and convert its bottom into meadows and ranches? Flooding the Hetch Hetchy valley will not detract in any degree from its beauty, but, on the other hand, will add a new beauty, a new point of interest and a new center for camping that will increase the usefulness of the park.

Preparation for Public-Utility Regulation

A paper read by Mr. William J. Norton, secretary of the rate research committee of the National Electric Light Association, before the Michigan section of that association some weeks ago suggests the necessity of a preliminary preparatory period of regulation for public utilities before complete regulation is imposed. The ideas underlying the suggestion are that the utilities were developed under conditions laid down or permitted by the public different from those which the public now seeks to impose and that the companies need a period in which they can adjust themselves, with reasonable protection of their properties and securities, to the altered conditions.

Formerly although a perfunctory form of approval was given to issues of securities in some sections of the country, most of the States let the companies have a free hand in capitalization. They also let the companies make their own agreements as to rates with the municipalities served; and the motive of the municipalities, at any rate in the early days, was to avoid the exaction of any terms which would so frighten the capitalists who were considering investment that the negotiations would be abandoned. In other words, the municipalities wanted the service so badly that they were not particular as to the terms on which it was to be had. These conditions permitted companies in some cases to fix terms which were unduly onerous to the public, and frequently adroit advantage was taken of the possibilities thus discerned by the controlling bankers. However, notwithstanding the execution of franchise contracts permitting high rates for heat and light, for instance, the management of many companies passed from the hands of the early promoters to able, experienced, technical officials, who introduced reforms in all departments. Important among the improvements effected was the reduction of rates to a point where they would stimulate rather than discourage business. It is true that this movement was actuated by shrewd business motives, but it was also a pure economic movement of that character which promotes the interest of the public equally with the interest of the company.

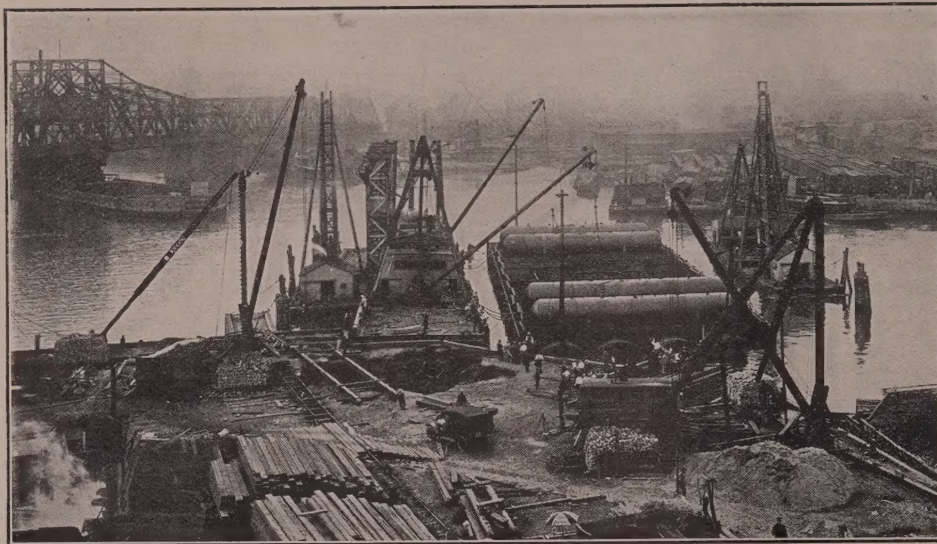
The proportion of public-service companies that managed their affairs prudently was not large enough to fix the characteristic behavior of the entire body of companies, and loose or worse financial practice began to grow. These brought about the present era of regulation. Some of the practices which led to greatly inflated capitalization, as compared with the value of the property which actually contributed to the usefulness of the plant at a given time, had their origin in part in that rapid progress of the art which made it necessary for companies to discard apparatus from time to time. No class of public-service company has been free from this burden. The largest example of this kind which we have had in the past is part of the progress of the street railway, from horse to cable and then to electric power. The most important issue of the

kind which we are likely to have in the near future, so far as it is possible to tell now, is impending in the problems relating to steam railroads which are raised by the loud public outcry for the discarding of wooden and the substitution of steel passenger cars and the electrification, first, of terminals, and, later, of outlying mileage.

Some of the capitalization due to causes of this general character is a legitimate part of the cost of properties and should be so recognized. If there is any part of the capitalization which cannot be recognized with justice to the public, some fair means for the decapitalization of that part should, if possible, be found. As to the reasonable elements of cost value which entered fairly into the proper upbuilding of the property, but represent property that has disappeared in the march of progress, the community has generally enjoyed benefits from the improvements which make it its duty to refrain from destroying the securities representing them. Certainly the public cannot rightfully expect a company which is paying a reasonable return on a fair cost value to forego that return for a long period of years so as to wipe out of its property account the cost of wooden passenger cars which are perfectly sound for operation in order that it may in that way provide funds for the purchase of steel cars. The only immediate alternative is to let the property account be swelled to the extent that it is necessary for the improvements desired; then the amount of the cost can be either retained permanently in the property account or retired during some period to be agreed upon between the company which shoulders the financial burden and the public which is benefited thereby.

In time the value of the property and the capitalization representing it ought to be approximately the same, for the general trend of present regulation is in that direction. But it is evident that any sudden attempt to make them the same, other than a straightforward agreement providing for reasonable protection for outstanding securities issued legally in cases where the proceeds were expended honestly for proper purposes, will lead to financial disturbances that may culminate in disaster. The public should not unhesitatingly ask the public-utility corporation to effect overnight such a balancing between value and capitalization as it has rarely effected for itself in the case of public works. The proportion of lost margin between the value of public works and the total of the municipal bonds issued to provide the funds therefor is not a whit smaller in many cases than the like margin of public-utility companies. Both issues present problems that ought to be considered and remedied and held as lessons for the future. Neither should be dealt with arbitrarily or in a spirit of reprisal.

If sufficient time is allowed, any proper excess of capitalization that exists in specific cases, either of public or private investment, can be amortized over a period of time which should be made so long that the rates necessary to provide for it will be only slightly more than those that would be necessary anyway. Whether this period is long or short the circumstances of each company or municipality would determine. A regulating body could fix the method and duration of amortization and with the completion of the period determined for this purpose, the State would be assured that capitalization and value were identical, provided, of course, no new inventions or public requirements involving radical reconstruction of plant arose to disturb the plan.



Tunnel Tubes, Partly Filled with Water, Floated by Contained Air

Floating and Sinking the Harlem River Section of the New York Subway

How a Four-Track Tube Was Placed in 60 Feet of Water without Resorting to the Usual Methods of Compressed-Air Tunneling

For the first time in the history of subaqueous subway construction in New York City a radical departure from the usual methods of building the tubes in place by compressed-air tunneling methods has been made. On the afternoon of Aug. 29 an 8000-ton section of four-track steel lining, 220 ft. long, 26 ft. wide and 24 ft. deep, which had been assembled and riveted on shore, was floated out into the Harlem River and sunk into position through 60 ft. of water, following the general scheme employed successfully in building the Michigan Central Railroad's Detroit River tunnels in Detroit.

After the ponderous mass of steel had been launched and towed a mile against a strong tide it was accurately centered over its final resting place. Then, manned by a force of only twenty-five workers, it was scuttled and in forty-two minutes was sunk to submersion and remained for a short time safely suspended just below the surface. After the final lowering through 20 ft. of water, which took seven minutes, the four 19-ft. tubes rested safely upon a prepared bearing in the bottom of a dredged trench.

The enormous mass was at all times under perfect control, was handled without any surges, plunging or violent or dangerous movements and the structure was placed in position far below the surface without the use of guides or complicated apparatus. Work was carried out strictly in accordance with a detailed schedule of time and operation, which made ample provision for all of the difficult conditions under which the work was executed.

The vital element of this method consists in the provision for controlling the escape of air from the closed subway tubes, the regulation of the water admitted to them, and the provision of an auxiliary system of temporary water-ballasted air floats attached to the tubes. The tubes were suspended below the surface from the floats to which their submerged weight was transferred and offset by an easily varied buoyancy. This buoyancy was finally reduced to a point where the weight of the submerged mass could be quickly and accurately handled by the hoisting engines, through which the principal movements

and delicate adjustments were readily controlled.

The four tracks of the Lexington Avenue subway will cross under the Harlem River in a tunnel about 76 ft. wide and 1080 ft. long, with its roof only about 5 ft. below the bottom of the river. Each track is located in a separate flattened steel tube, 19 ft. in diameter and 2 ft. in the clear from the adjacent tube at the same level. All of the tubes are inclosed in a mass of concrete deposited in place and having cross-sectional dimensions of 76 x 24½ ft.

The work is now being executed, largely on dry land, without involving any tunnel excavation or the use of compressed air. A set of four lining tubes, about 220 ft. long and weighing about 1,300,000 lb., is riveted up complete on shore, floated to position and lowered about 60 ft. to the required level and alignment in the previously dredged trench, connected and inclosed in concrete, following, on a larger scale, substantially the same method that was used for a similar track tunnel for the Michigan Central Railroad

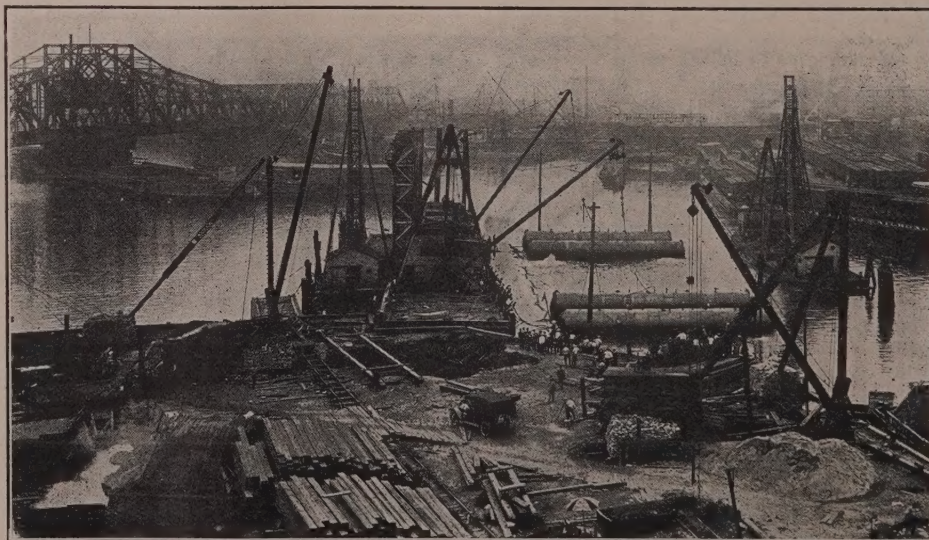
across the Detroit River, as described in the Engineering Record of Dec. 13, 1909, page 678, the details of the permanent structure, the method of construction and the difficult and unusual features of sinking being in both cases designed and executed by Mr. Olaf Hoff, engineer and contractor. The first set of steel tubes for the Harlem River Tunnel was sunk to exact position and alignment in three hours by a force of only twenty-five men, with two derricks and ordinary hoisting engines, to control the 7440-ton mass, with great ease, accuracy, and rapidity.

LAUNCHING AND FLOATING THE TUBES

Steel for the tubes was fabricated, ready for riveting, at the bridge shops and shipped to the site, where it was assembled and riveted up on pile falsework driven in a slip at the contractor's yard on the Harlem River at a considerable distance from the tunnel site. The tubes are connected by rectangular vertical transverse steel plate diaphragms about 15 ft. apart, which project about 3 ft. beyond the tubes. To the vertical outer edges of the diaphragms was attached a sheeting of vertical planks, which, with the diaphragms, formed a series of pockets open at top and bottom and entirely inclosing the tube to form receptacles for the concrete casing of the tubes.

Both ends of the two outer tubes were entirely closed with temporary heavy wooden bulkheads, similar bulkheads having been built in the lower portions of the ends of the center tubes, thus providing buoyancy for floating. In the upper part of each of the outside tubes there were also placed two vertical transverse semi-bulkheads, called air curtains, which were 11 ft. deep, thus extending down below the center lines of the tubes. In each of the end compartments thus formed a 2-in. air escape valve was set at the top of the tube, and in each of the center compartments there were two 3-in. air escapes.

The bulkheads at the shore end of the tunnel tubes were made very heavy to resist full external hydraulic pressure after the tubes are pumped out. The other bulkheads were made much lighter, with strength only proportioned to resist differences of pressure due to the 4-ft. difference of level in the interior and exterior waters. Each of the heavy bulkheads were provided near the bottom with a 12-in. inlet commanded by a 12-in. valve with a long vertical stem and a similar 10-in. outlet valve for pumping out the tubes later on. The light bulkheads were each provided with a single 12-in. valved inlet.



Tunnel Tubes Filled with Water and Suspended Submerged from Air Cylinders

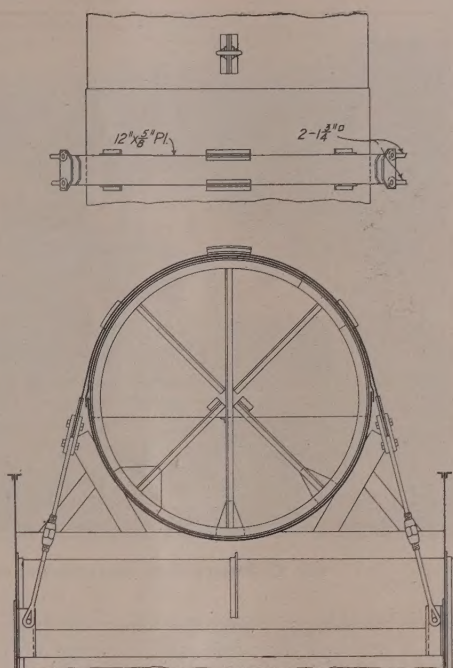
As riveted up, the transverse diaphragms connecting the four tubes were supported on four longitudinal lines of stringers 18 ft. apart. In each of the spaces between them three water-ballasted wooden scows, with a capacity of 100 tons each, were placed at low tide, and on a rising tide they lifted the steel tubes from the falsework and were towed to a convenient mooring near by, where they were stored until towed to position and sunk.

Enough water ballast was admitted to the scows to overcome all but a small portion of their buoyancy due to the specific gravity of the wood, allowing the tubes to sink until their own displacement nearly sufficed for flotation. The pressure between the scows and the tubes was thus so much reduced that the former were easily pulled out from under the latter, leaving them floating independently and releasing the scows for further use.

PNEUMATIC SINKING CONTROL

While the tubes were floating there were connected to them four 10½-ft. air cylinders 65 ft. long, by which the sinking of the tubes was controlled. The cylinders had domed ends and were divided into three compartments by a pair of interior domed heads with concave sides near the center, set 5 ft. 3 in. each side of the center of the cylinder.

The center compartments were each provided with a 3-in. bottom inlet in the center having a valve with the vertical stem passing through a stuffing box in the top of the cylinder, a 2-in. valve outlet in the center of the top and a 3-in. valve outlet with hose connection on top of the tube on an interior standpipe extending nearly to the bottom of the tube. Each of the end compartments had a similar outlet valve and hose connection, thus providing for the admission of water into all



Section B-B

Air Cylinder Connected to Tubes

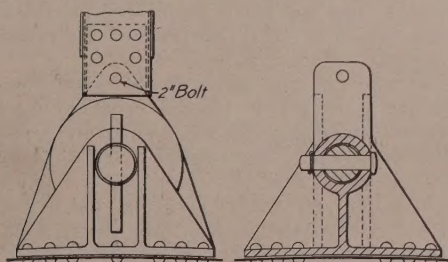
parts of the cylinder and for its removal from the center part, if necessary.

The cylinders were seated on top of the tubes in the first and third pockets from each end and were secured by four pairs of inclined 1¾-in. sleeve-nut rods pin-connected at the upper ends to semicircular steel saddles over the tops of the cylinders and pin-connected at the lower ends to the tube diaphragms.

Temporary vertical steel masts 43 ft. long,

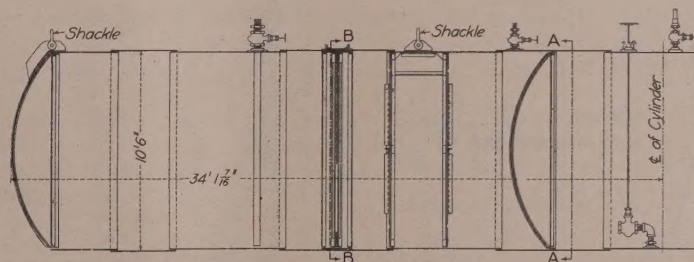
four in all, were set on the ends of the outside tubes to provide for their accurate alignment and leveling and to indicate their exact positions when submerged. The lower ends of the masts were pivoted to the tubes and the upper ends were pivoted to inclined longitudinal stifflegs. The lower ends of the stifflegs were adjustably connected to the tubes by pairs of screw rods, with their lower ends pin-connected to the tubes and their upper ends passing through sleeves on the stifflegs, with nut bearings on both ends of the sleeves. Each mast was also guyed by two transverse sleeve-nut rods, thus providing for plumbing in any direction. In order to maintain both masts simultaneously in line they were provided with horizontal arms carrying targets eccentric from the axis of the tube, so that the transit, being set up with corresponding offset from the tube axis, could easily maintain the alignment and at the same time readily keep the targets at both ends of the tube in the same plane, one above the other.

Each joint between the tunnel sections is provided with two horizontal longitudinal 5-in. assembling pins about 3 ft. long, with fixed bearing at one end in a casting which receives the foot of the steel mast and is riveted to the first sunk tube. The other end of the pin projects about 2 ft. beyond the end of the tube and is pointed to act as a pilot, readily engaging the coned hole in a corresponding casting on the end of the second sunk tube, which is thus automatically centered. When the adjustment is completed a diver locks the tubes together by the insertion of a tapered key in the pilot pin. These pins are, of course, not required at the land end of the tunnel, but they were provided in the casting at the river end of the first section, ready for use when the adjacent section is sunk.



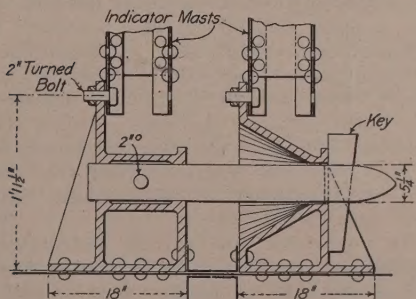
Section C-C

Section D-D

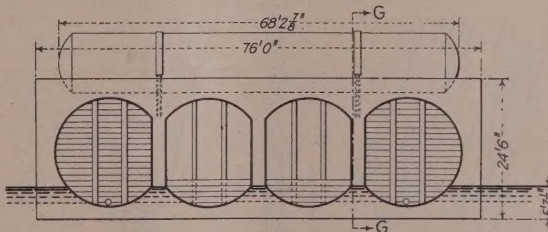


Part Longitudinal Section

Air Cylinder Temporarily Connected to Tubes during Sinking

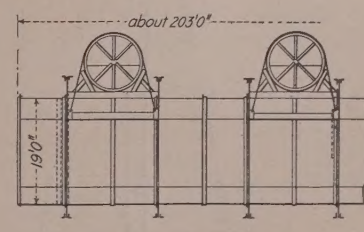


Section E-E

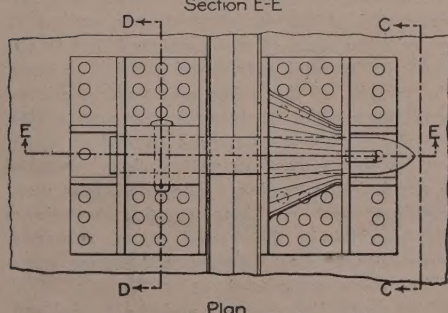


End Elevation

Steel Tubes as Floated to Position with Bulkheads and Air Cylinders

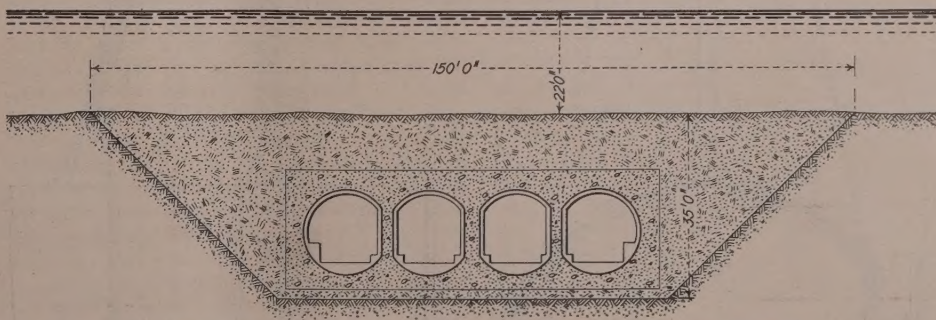


Part Section G-G



Plan

Pilot Pin and Bearings



Cross-Section of Completed Tunnel in Backfilled Dredged Trench

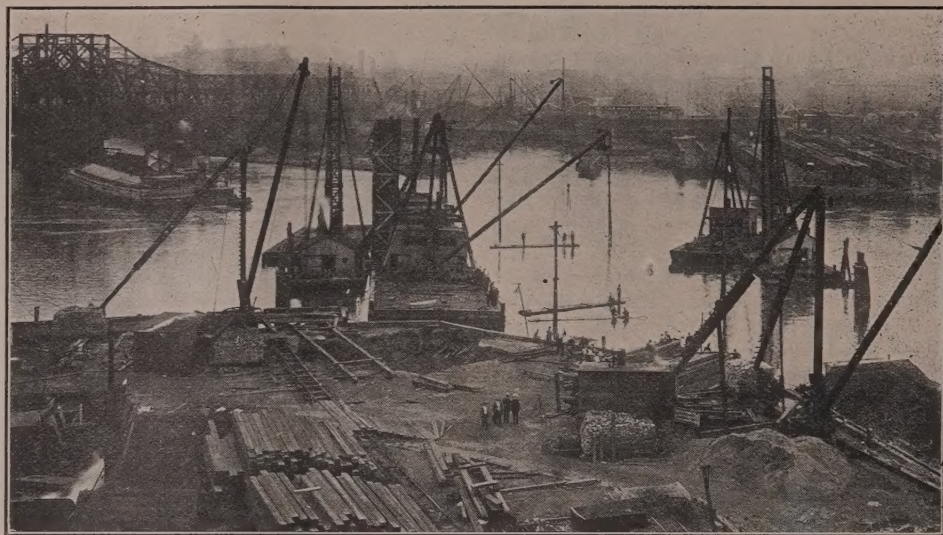
Open excavation to subgrade of the tunnel was made by dredging a trench about 80 ft. wide at the bottom with sloping sides to a total depth of about 30 ft. below the bottom of the river, or nearly 60 ft. below high tide. This was accomplished by the use of clam-shell dredges discharging into dump scows alongside. After the trench was excavated five horizontal longitudinal sills were set in it to support each end of the first section of the tube at the exact required level, about 3 or 4 ft. above the bottom of the trench.

Each sill consisted of a pair of 12-in. vertical web channels about 5 ft. long and 12 in. apart, bolted together with flanges turned in. The ends of the channels were provided with gusset plates riveted to their webs and bolted to the upper ends of single wooden piles about 10 ft. long, notched to receive the channel flanges.

The gusset plates thus serve as kneebraces to stiffen the light bents, which were carefully lowered to position and driven by a pair of floating steam hammer pile drivers simultaneously operated on two 12 x 12-in. steel columns about 55 ft. long, which were seated on the ends of the bents, which they engaged with jaw plates, and served as followers to drive the piles under water. They were properly aligned in position and driven to gage marks leveled up on the followers, which reduced the errors to less than $\frac{1}{4}$ in. in their elevations. The bents were all driven until the sills were in the same horizontal plane where they afforded bearings for the bottom flanges of the tube diaphragms.

SINKING THE TUBES

The section floating with the middle tubes empty had a draft of 3 ft. $4\frac{1}{2}$ in. to the bottoms of the tubes and 5 ft. 7 in. to the bottoms



Air Cylinders Scuttled and Tunnel Tubes Suspended from Derricks

of the diaphragms; with the inner tube bulkheads removed the draft was increased to 5 ft. 8 in. and 7 ft. 11 in. respectively. At 10 a. m. Aug. 29 it left its moorings and was towed to position by two tugs in front and one behind. It was towed about 1 mile against a 3-mile maximum tidal current and passed through three drawbridges, arriving at the destination at 12.30 p. m.

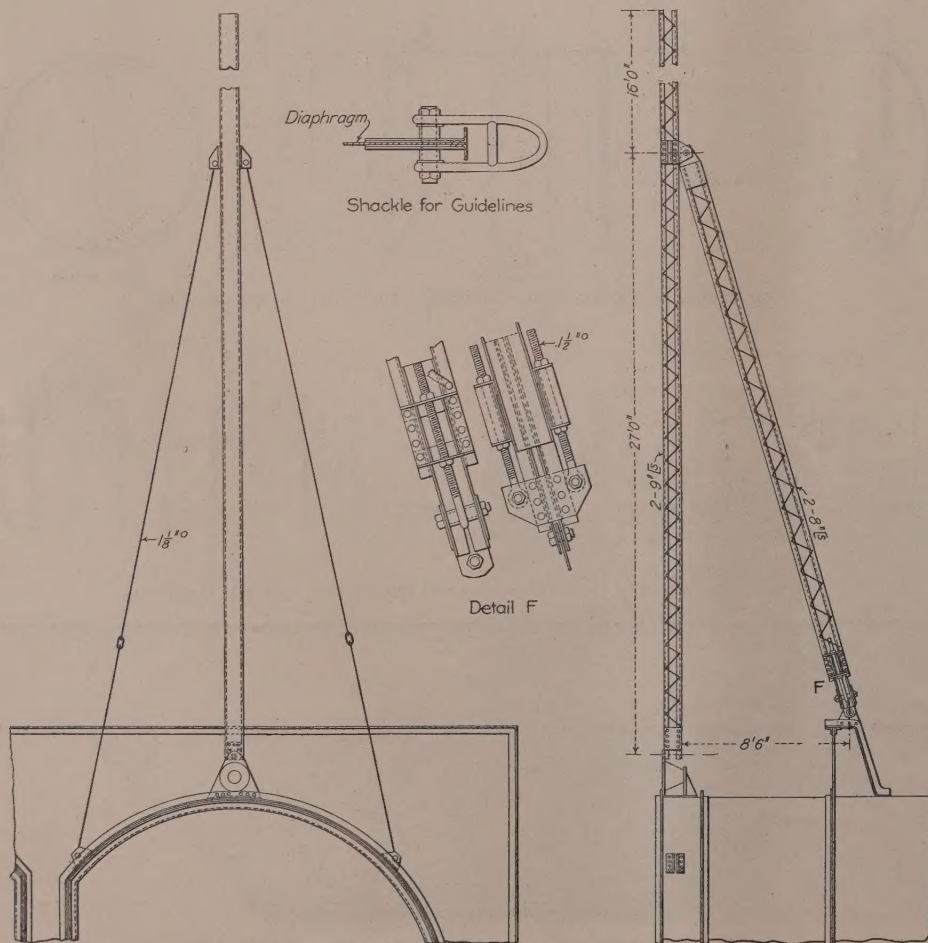
The air-escape hose and valves were attached to the 2-in. air escapes at the top of the outer tubes; five guide lines were shackled to each end diaphragm and a bridle attached to each end of the section was connected to the hoisting tackle of the 80-ft. boom on a floating derrick.

The bulkheads having been partly removed from the ends of the center tubes the 12-in. valves in the end bulkheads of the outer tubes were opened at 2.04 p. m. and the tubes sunk rapidly and steadily until they were completely submerged at 2.46 p. m., when the air cylinders touched the surface of the water. Considerable air still remained trapped between the bulkheads and air curtains of the outside tubes, and being gradually released through the outlet valves the tubes were maintained in a horizontal position and steadied while sinking.

At 3.10 the trapped air having completely escaped, the main tubes were entirely filled with water and descended a short distance below the surface of the river, being suspended from the partly submerged air cylinders, which at that time exerted an excess buoyancy of about 19 tons each.

At 3.10 the inlet valves in the center compartments of all of the air cylinders were opened and water was admitted to overcome this buoyancy. The cylinders acted virtually like inverted bases to maintain the tube's equilibrium and prevent plunging, and gradually they descended as the tubes slowly filled. They maintained almost perfect level, and at 4.50 p. m. the air cylinders were completely submerged and were sustained by the derricks, one at each end, which were subjected to a lifting stress estimated at 5 tons on each, giving a perfect and delicate control of the tubes, which were then about 20 ft. above their final required position. At this time the total weight of the tubes, cylinders, fittings, lumber and contained water amounted to about 7440 tons, the displacement being only about 10 tons less.

At 5.03 o'clock the derrick tackles were slacked and the tubes were lowered to bearing on the sills, where they were seated at 5.10, resting at first with a longitudinal displacement of 2.2 ft. to the north and 4 ft. out of alignment at the river end due to the effect of the tidal current of 3 miles an hour. The weight of the tubes was partly relieved by taking a slight strain on the derrick tackles, and the tunnel section was moved to exact position by four four-part tackles operated by the hoisting engine. The conditions were examined and positions verified by divers and checked by level and transit observations on the mast targets, the entire operation being completed at 7 o'clock. The tackles were disconnected and the tunnel section was left in stable equilibrium, with about 10 tons bearing on the sills, which was con-



Adjustable Temporary Mast for Locating Tubes Under Water

sidered entirely adequate to hold it safely in position in the dead water at the bottom of the trench.

The submerged weight of the tunnel section and its pneumatic cylinders was about 76½ tons, requiring an equivalent amount of water to be admitted to the pneumatic cylinders to sink the tubes to the bottom. The total weight of permanent steel and lumber is about 1,590,000 lb. in air and the total weight under water of both temporary and permanent steel and timber was about 1,292,000 lb.

COMPLETING THE TUNNEL

The four succeeding sections of the tunnel will be sunk in a similar manner, and each of them will be adjusted and connected to the forward end of the preceding section by means of the pilot pins already described. As fast as each section is sunk to position it will be inclosed in a solid mass of concrete filling the pockets and resting on the bottom of the dredged trench. This concrete is now being deposited through five 12-in. tremie tubes, about 58-ft. long, which are installed on a concrete boat moored transversely across the tunnel section with a tremie delivering in each space between the tubes and outside of the outside tubes.

The 1:3:6 Dragon cement concrete is made with small-size aggregate and is mixed in three 1-yd. Lakewood machines. It spreads from the tremies over the dredged bottom under the tube, where it is carefully examined by the divers, who make certain that no voids are left.

In the comparison of this work with that of the similar work in the Detroit River tunnel it is interesting to note that this section, weighing 50 per cent more than the heaviest of the ten Detroit River sections, was sunk more quickly than any of the Detroit sections. After the exterior concreting is finished the tubes will be pumped out and lined with concrete, completing the tunnel construction.

Work is being executed under the direction of the Public Service Commission, of which Mr. Alfred Craven is chief engineer; Mr. Robert Ridgway, engineer of subway construction, and Mr. C. V. V. Powers, division engineer. Arthur McMullen & Olaff Hoff are the contractors, for whom Mr. N. R. Melvin is superintendent in charge.

Retired Panama Canal Equipment

The committee appointed to consider plans for storing, pending its ultimate disposal, canal commission equipment no longer needed for construction purposes has made its report, according to the "Canal Record," and the report has been approved. In view of the contemplated abandonment of the towns on the west side of the canal between Gorgona and Pedro Miguel, only the tracks on the east side adjacent to the Panama Railroad were considered. Inspection of these tracks showed that those at the Cristobal shops are not available, being used for operating purposes. Practically all of the Gamboa yard is available, or about 5000 ft. of track, making allowance for necessary alterations for connections. In the yard and approaches to the relocation dumps between Gamboa dump and dump No. 7 it is estimated that 36,000 ft. will be available, with 27,000 ft. more on the dumps proper. In the opinion of the committee sheltered storage for the large equipment is not feasible, but it thinks the Gamboa yard would be the best place for it, to minimize the switching. The tracks on the dumps would be used for storing cars, and the remaining tracks, for various classes of equipment.

Negative-Head Patent Decision

Opinion of Circuit Court in Case of Mechanical Filters at Harrisburg

A decision was rendered in favor of the New York Continental Jewell Filtration Company in the United States Circuit Court for the Middle District of Pennsylvania on Aug. 25 in the suit brought by that company against the city of Harrisburg for infringing the plaintiff's patent on the use of negative head, or down draft, in rapid sand filters. The defendant has asked for a rehearing, and the motion will be argued in the near future. The litigation has been in progress since 1908, and on account of its importance has attracted much attention among waterworks engineers. Those who testified for the defendant included such eminent authorities as Messrs. Allen Hazen, George W. Fuller and James H. Fuertes, while for the plaintiff, besides Mr. Robert E. Milligan of the Continental Jewell Company and the officers of other filter companies, Mr. George A. Johnson and Prof. William P. Mason appeared. The plant in which infringement was claimed was built in 1905, Mr. Fuertes being the engineer. Other alleged infringers of the same patent joined Harrisburg in the defense, furnishing money and services. Among these were the cities of New Orleans and Columbus, the Louisville Water Company and the Hackensack Water Company.

The patents in suit are No. 644,137, dated Feb. 27, 1900, and Reissue No. 11,672, dated June 28, 1898 (original number 546,738, dated Sept. 24, 1895). The patent which was reissued will therefore expire on Sept. 24, 1912, while the former one runs until Feb. 27, 1917.

The following extract gives the principal points of the decision:

FUNCTION OF THE SCHMUTZDECKE

It would thus seem that in slow filtration plants, the efficient agent of filtration is the surface sediment layer. Where more rapid or mechanical filtration was necessary, coagulants were used and what corresponds to the "schmutzdecke" was by them formed in a few minutes, the coagulants forcing the impurities together like curd in milk. The proofs, as will be seen in extracts quoted below, show that this surface sediment layer is usually found in a stratified zone, distinct from the sand bed beneath, and that there was little if any penetration of the gelatinous sediment matter into the latter. It also appears from such proofs that as the surface sediment layer thickened, it was so compacted by the water head pressing on it, that little water passed through it. But not only did such surface layer tend to eventually prevent percolation, but its compact shell tended to create a vacuum beneath, which latter, by liberating the air in the passing water, still further impeded percolation. This arose from the fact that water, under high pressure, retains very considerable air, which, as a vacuum is formed and the water is subjected to less pressure, is released. But this released air tends to fill and clog the interstices between the sand grains and thereby clog the water flow.

The proofs also show that this vacuum liberated air, owing to the slow and retarded passage of the water, was not carried off, but at times bubbled upward and ruptured the schmutzdecke. This rupture allowed unfiltered water to pass into the sand bed until by its impurities such passing fluid gradually closed up the ruptured layer and restored the schmutzdecke to a condition of filtering efficiency.

In this state of the art; with the slow formation of the surface sediment layer; with that layer constituting virtually the sole potent factor of filtration; with the sand bed's being practically confined to forming the surface sediment shell; with vacuum regarded as a retarder of filtration; and tending to lessen plant output, the patents here in question entered the art. In that art, as we have seen, the only water impelling force utilized came from gravity, as stated by one of the defendant's witnesses, who said: "In case of positive filters the water passed through the filter by virtue of its own weights and the pressure of the superincumbent water above the sand surface." To that art, which regarded vacuum as an evil, Jewell, in his process, disclosed the radical and revolutionary suggestion that this vacuum, if of such relative completeness as to utilize its efficiency, could be made, not only to avoid all troubles incident to air-releasing, but to utilize the whole sand bed as an active filtering agency. In other words he claimed by the proper use of vacuum, to virtually convert the entire sand body into a quasi schmutzdecke.

The practical outcome of Jewell's process has been to create in sand filtration, a new, distinctly recognized and differential type of plant known as the down-draft or negative head filter. It is bottomed on a designedly created vacuum, which in the words of the extracts quoted results from "an off-carrying pipe vertically arranged and of such length that as the filtered water is carried off by said pipe, a partial vacuum will be created within the filter bed." And "it extends downward a sufficient distance to provide the necessary down-draft, usually several feet." Its action as stated, is that "the entire body of filtering material is utilized instead of substantially the upper surface only, as in prior construction." These extracts clearly show that from the patentee's viewpoint, the gist of his invention was the utilization of the whole sand bed as a filtering agency and this he meant to secure by the designated creation of an impelling vacuum.

USE OF WHOLE SAND BODY AS FILTERING AGENCY

While there are views and contentions to the contrary in this voluminous record, every part of which has had our thoughtful examination, we are constrained by the fair weight of the evidence to find, as we do, that the process and apparatus disclosed by Jewell in his patent here involved, do in practical use, by the creation of a vacuum utilize the whole sand body as a filtering agency as it was never used before.

Indeed that the workings of a down-draft or negative head filter must, in the nature of things, be different from a gravity or positive head filter is self-evident, from the fact of its calling into play the powerful agency of atmospheric pressure. From this we can readily understand that such atmospheric force, whether venting itself as a weight from above or a suction from below, must cause new results in a process, the basic element of which is the pressure passage of liquid through impeding matter. On the surface, Jewell's change seems slight; in fact the mere adding of a water-sealed, vertical off-take pipe. In substance and practical worth it has evidently added to the filtration art a factor and proven so important as to warrant the expenditure by

the defendant and its associate cities, of the time, labor and expenses involved in this large record. Were the contention that this vertical off-take worked no substantial change from gravity filters, it would very likely have been abandoned. On the other hand, the continued use thereof tends to support the contention of plaintiff's witnesses that the change effected thereby is substantial and valuable.

The difference between the penetration observed in gravity and down-draft filters is also testified to [a number of previous quotations of the same import have been omitted] by the witness Ryan, an experienced filtration engineer. When asked as to his observations in testing plants, in which branch his work was of very considerable extent, he says: "In the case of positive head filters, the sediment layer is usually much thicker than in the case of a negative head filter. Also in the case of a negative head filter I have usually found that it usually penetrates into the bed which is not the case with a positive head filter. . . . In some cases (of a positive head filter) I have seen this sediment of such a character that it could be scraped off the top, leaving the sand below practically clean. . . . The negative head filter has the layer on the surface of the sand much thinner, and if the sand is examined at considerable depth below the surface, say to 16 in., usually there will be found some of the coagulated matter, not 24 in. under the surface, but actually coming through the effluent pipes of the negative head filter;" a fact also observed by the witness Roberts.

OPINION ON THE JEWELL CLAIMS

Without referring further to the numerous witnesses called or discussing the many other questions involved or raised by witnesses in general, we restrict ourselves to stating that our study of the case satisfies us that Jewell's process does, by the use of a down-shaft, sealed, vertical outlet pipe create and maintain an operative vacuum which vacuum effects a deeper utilization of the sand body for filtration than in positive head filters; that the presence of released air incident to the use of a down-draft vacuum is helpful and not harmful by reason of the velocity imparted to the passing water by such vacuum; that the process makes the runs longer and both structural and maintenance costs are lessened by its use. Indeed, that vacuum draft increases run lengths is, we understand conceded by defendant, the only question being the amount.

We next turn to the question whether Jewell's disclosure involved invention. That it was an original conception as contrasted with an obvious expedient is clear, for even now that its working efficiency has been shown, no one can yet explain how it works, or why it should produce the results it does. His disclosure was not the mere material suggestion of the use of the down-draft tube to create a vacuum. The originality and substance of his disclosure was in the utilization of a vacuum. His apparatus was simply the concrete means suggested to utilize the process. This disclosure was a marked departure from the previous ideas and practice; it gave to the whole of the large sand body of the art a compacted, functional working capacity it did not previously have; it created a new type of filter in the art; the process has gone into widespread and extensive use. We are therefore of opinion that Jewell's disclosure involved invention and that his general process claim, viz.: "The method of purifying water which consists in passing the impure water through a granular filter bed having an exposed filter-

ing surface, and at the same time applying suction from below substantially as described" and the modifications thereof embodied in his other claims should be sustained. Nor do we think the merit of his disclosure or the substantial reward of a patent should be denied him by reason of anything that preceded him in filtration practice, theory or patent. That the existence of a vacuum in filtration experiments was observed and commented upon prior to Jewell, may for present purposes be assumed. His merit consisted in pointing out that an objectionable vacuum could, if properly used, be made to cause deeper penetration, with the substantial benefits incident thereto.

PREVIOUS KNOWLEDGE OF VACUUM IN FILTERS

For example, the presence of a vacuum from time to time in filtration was observed and attention was directed thereto in the experiments at Lawrence. We assume for the present purpose, but without so deciding, that the references thereto in Hazen's book were prior to Jewell's. But those facts only serve to emphasize the original and valuable character of Jewell's subsequent disclosure. For it is clear that with the attention of this scientific experimental staff drawn to the subject, with such information presumably imparted to the many engineers and scientists engaged in the subject of filtration, no one was led thereby to discover that a vacuum could be used to deepen penetration. Indeed as showing the then total lack of appreciation of the dormant and undiscovered capacity of a down-draft vacuum to increase run lengths, and that vacuum was regarded as a mere negligible, occasional, undesigned and objectionable feature, we may refer to the testimony of the witness Hazen, who says: "I have already described how the negative head occurred in some of the experimental filters at Lawrence. The negative head occurred without any special design or intention, although its occurrence was noted and its practical significance more or less thoroughly understood. How frequently it occurred and how large an element it was in producing the results cannot be now determined." That in point of fact such down-draft was then regarded as objectionable and that means were taken, by increasing the gravity head, to avoid it is, we think, clearly shown in Hazen's work, "Filtration of Public Water Supplies." "It is also customary to have a depth of water on the filter in excess of the maximum loss of head, so that there can never be a suction in the sand just below the sediment layer. . . . The suction only commences to exist as the increasing head becomes greater than the depth of the water, and there is no way in which air from the outside can get in to reduce it. In these experimental filters, in winter, when the water is completely saturated with air, a small part of the air comes out of the water just as it passes the sediment layer and gets into reduced pressure, and this air prevents the satisfactory operation of the filters.

From this it is clear that regarding the Lawrence Experimental Station, as we are justified in doing, as evidencing the most progressive views of the filtration art, it would seem that vacuum was regarded as objectionable. The aim was to exclude, not to utilize it. Had the art maintained its then attitude toward vacuum—filtration's most valuable and most misunderstood servant—there would have been no evolution of down-draft filtration. Indeed, to our mind, these Lawrence observations of vacuum are strong proofs of originality in Jewell's work. When it is borne in mind that filtration was then a subject of general study

and vital interest; that an earnest body of sanitary engineers, scientists and municipal officers were devoting themselves to its problems; when its processes were being made the specialized study of a State experimental plant, for a patentee to take up a feature, which while known, was deemed objectionable; and show that such feature could be made a serviceable and important element of filtration, justifies a court in sustaining the patent the office gave him. For assuredly a court, in the light of the practical results in the working of the process, has a much stronger case before it than the patent office had when Jewell's process was comparatively theoretical.

We have therefore reached the conclusion that Jewell's process was useful, novel and inventive and that the claims thereof should be sustained unless anticipated.

QUESTION OF PRIORITY

As usual in such cases, a large number of publications, use and patents are cited which it is alleged should establish anticipation. That they did not is clear. All of such data were within the range of knowledge of acute men who were working to improve the art. The public demand was for effective and sufficient filtration. Manifestly, men of presumably much deeper and broader scientific ability than Jewell were studying the subject, yet none of these men were led by this wealth of alleged anticipation to utilize vacuum. At the argument, and in reply to an inquiry by the court, counsel for defendant cited the British patent of Neville, No. 6,160 of 1831, as the nearest approach to Jewell. This patent was considered by the office in the progress of Jewell's application. By his disclaimer and the limitation of his claims, Jewell recognizes Neville's patent, but beyond that the office gave it no effect as an anticipation. In our view this was right. While the two patents concern the general subject of filtration and while, as Professor Langley, one of the defendant's witnesses, aptly expresses it, Neville clearly apprehended "the use of a downdraft tube and the physics of its operation," it is also clear that the problems before the two men were not the same. They were using the vacuum for wholly different purposes in filtration and the device of Neville threw no light on Jewell's work.

Deeper penetration was not involved in the effect Neville had in view. Indeed the success of his device, if, in fact, it was successful, evidently centered on substantially the whole of the filtering being done by the felt cover, for he made no provision for cleaning the rammed substratum. It would seem, therefore, that deeper gelatinous penetration was to be avoided. It is therefore clear that Neville threw no helpful light on the problem of deeper penetration which Jewell solved more than half a century later. It should be borne in mind also that Jewell's device was not only scientifically meritorious, and a patent therefore a just and earned reward to an inventor of more than an ordinary desert, but that in the field of altruistic and humane work he made a substantial contribution to the advancement of public health and welfare. The reasoning applicable to his process warrants a decree in the apparatus patent in which he discovered how his process could be utilized.

On the subject of infringement little need be said. The defendant's plant has a down-draft, sealed suction apparatus, a loose granular, exposed surface filter-bed and that it operates by the patented process is established by the weight of the evidence. Indeed the plant is seemingly based and patterned after the Little Falls one. A decree may be prepared in accordance with these views.

NEW ENGLAND WATERWORKS ASSOCIATION

Abstracts of Some of the Papers Presented at the Thirty-Second Annual Convention, Held in Philadelphia, September 10 to 12

Water-Waste Prevention in New York City

By William W. Brush, Deputy Chief Engineer,
Department of Water, Gas and Electricity,
New York City

As a result of an extensive crusade against water waste, covering a period of three years, the consumption of New York City was reduced from 525,000,000 gal. per day in 1910 to 486,000,000 gal. at the present time. Allowing for yearly increase of population, this reduction is equivalent to 90,000,000 gal. daily. This saving was effected at a net cost of \$100,000 by means of pitometer surveys, house-to-house inspection and a general educational campaign conducted by the Department of Water Supply, Gas and Electricity.

Conditions in Manhattan and The Bronx are unusually favorable to the development and continuance of leaks from mains and services outside of buildings without any indication on the surface. In rock-underlaid streets the water main is usually laid in the sewer trench and the filling offers comparatively free passageway for the leaking waters to reach the sewer. Under the above described conditions leaks amounting to several hundred thousand gallons daily might continue for years without discovery. Numerous leaks of 100,000 gal. daily have been found only after pitometer measurements have shown unreasonably high flows.

PULSOGRAPH TESTS

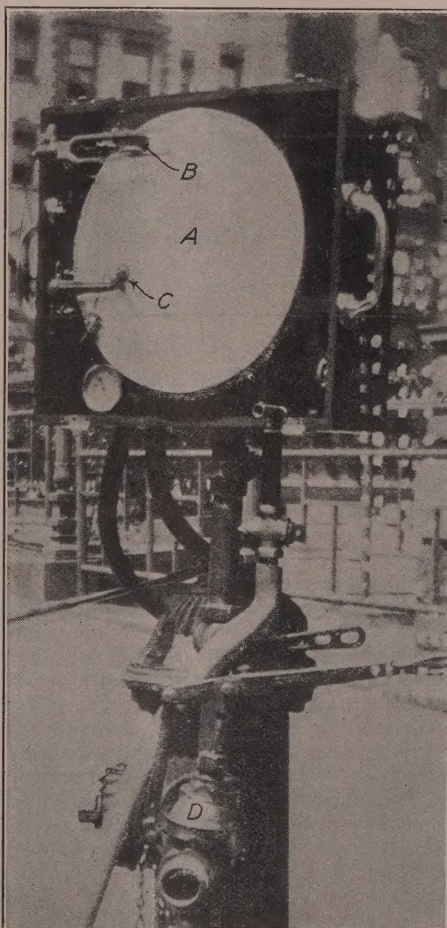
To simplify the location of these leaks and to reduce the cost of locating them, the department has recently used a "pulsograph," invented by Mr. A. Akinoff, of Philadelphia. This instrument is based upon the water hammer experiments made in Russia in 1897-8 and reported by N. Jonkowsky before the Russian Technical Society April 29, 1898. It consists essentially of a large sensitive pressure recorder having a rapid motion, a tuning fork vibrating at a rate of 200 per second, and a quick-operative valve, which is on a blowoff or by-pass pipe.

The instrument is set up by screwing it to a hydrant nozzle, the hydrant being chosen so that there will be a straight run of several hundred feet before an open four-way branch is encountered. By closing valves on intermediate branches the effect of a long, isolated line can be obtained. In operation, the valve on the main below the hydrant is closed and water is allowed to flow from the hydrant through the by-pass on the instrument. By quickly closing the by-pass valve a water hammer of about 15 lb. is created and recorded on the pressure gage. This pressure is maintained until the water-hammer pressure has reached the open branch at the end of the pipe line that is being tested and the drop in pressure has traveled back to the hydrant, the tuning fork vibrations showing the time for this double travel. By dividing twice the distance along the main to the open branch by the time, the rate of travel for the particular pipe is determined. This has been found to be approxi-



Partially Blown Joint

Leakage 29,000 gallons daily



Pulsograph on Hydrant

A, recording dial; B, time-recording vibrator; C, pressure recorder; D, quick-opening valve to create water hammer

mately 3600 ft. per second for 6-in. pipe, increasing to about 4200 ft. for 12-in. pipe. If there is any leak in the main, or in a service near the main, the water-hammer pressure is materially reduced and the chart shows separately the reduction due to the leak and the open branch. The distance to the leak can then be determined by multiplying the time shown on the chart for the water-hammer pressure to travel to the leak and return to the pulsograph by the determined rate of travel of the hammer pressure along the pipe, and dividing by 2. Several leaks have been located within limits of less than 20 ft. by the use of this instrument, and the results from its further use should be interesting, as a decided saving in cost of locating leaks is anticipated.

MINIMUM STORAGE REQUIRED

One phase of the determination of the need for an additional supply to offset the threatened shortage in 1910-11 was the fixing of the reasonable safe limit of depletion of storage on Jan. 1 of any year. The Rippl, or mass curve method, is usually adopted in determining the safe maximum draft from any watershed. The rule adopted for New York was that the storage should not go below an amount which, added to the lowest runoff recorded for a year, would equal the anticipated consumption for that year.

The lowest recorded runoff of the Croton watershed for a calendar year was 207,000,000 gal. daily. With the consumption reduced to 275,000,000 gal., the deficiency was 68,000,000 gal. daily, or 24,820,000,000 gal. in one year. As further reduction could at that time have been made in the consumption, if necessary, the figure of 20,000,000,000 gal. was adopted as the safe reserve supply for New York conditions in 1911; 323,000,000 gal. per day has been adopted as the safe rate of draft.

WATER-WASTE WORK IN THE FUTURE

With a gravity supply, which is the condition in Manhattan and The Bronx for about 75 per cent of the consumption, and with ample aqueduct and reservoir capacity, there is practically no difference in cost between a small and a large use of water, as the same force has to be employed to care for the watershed, reservoirs, aqueduct line and distribution system. The trunk main capacity is, however, affected by the rate of draft, as these mains, in a large, well-designed system, are normally proportioned to the needs for domestic consumption, with some margin for fire purposes. For about every 20,000,000 gal. daily added to the consumption a 48-in. main has to be laid, so that for each 20,000,000 gal. daily saved the laying of a 48-in. main can be eliminated. By taking the average length of trunk main required to deliver water from the end of the aqueduct to the center of distribution and determining the cost of such main the monetary value of water saved can be arrived at, assuming there is no reason to save water to prevent extensions to the supply system being required, which was the case in Manhattan and The Bronx in 1912. From the terminal of the aqueduct at 135th Street gate house, Manhattan, to the center of

distribution is estimated at 25,000 ft. Using a cost of \$18 per foot for laying a 48-in. main, the expense would total \$450,000. Assuming the capacity of the 48-in. main to be 20,000,000 gal. daily, the cost per 1,000,000 gal. capacity would be \$22,500. Assuming interest, sinking fund and maintenance at $5\frac{1}{2}$ per cent, the cost would be \$3.39 per 1,000,000 gal. As the lateral distributors in the distribution system are of a capacity based almost entirely on fire-service requirements, there would be no additional saving for such parts of the system, even if the consumption were to be reduced 20 per cent.

For the pumped supply the cost of maintenance and operation, including sinking fund on equipment, is equivalent to about \$10 per 1,000,000 gal.

From the above it is evident that for the present there is no financial return from reducing water waste where the cost of such saving exceeds \$10 per 1,000,000 gal. in districts where the water is pumped and \$3.39 per 1,000,000 gal. in districts where the water is delivered by gravity.

When the Catskill water supply is introduced and has been utilized to such an extent that pumping from the Brooklyn system will have to be resorted to if waste of water is not curtailed, a very different financial problem will be presented.

The work of preventing water waste was in charge of Mr. I. M. de Varona, chief engineer of the Department of Water, Gas and Electricity of New York City.

Maintenance of Meters and Effect on Revenue

By A. W. Cuddeback, Engineer and Superintendent, Passaic Water Company, Paterson, N. J.

The advent of the meter should check the needless waste going on under the old method, but it is necessary that the meter be adjusted to the work it should perform and be in good condition. Thus constant inspection is involved. The results obtained when changes were made in three typical instances show the economy of this inspection.

The first meter would not register on test a stream of 650 gal. per twenty-four hours, and its record curve for five quarters preceding its removal showed a uniform registration of about 3000 cu. ft. per quarter. The new meter showed a decided increase of registration for two quarters. The increase was due to leakage, which, if the normal use was from 3000 to 4000 cu. ft. per quarter, amounted to from 2000 to 3000 cu. ft. per quarter, or from 200 to 250 gal. per day, a flow that was below the point of registration of the meter that had been removed. The leak had in all probability been going on for some time before the change of meters was made.

The second meter would not register on test a flow of 1100 gal. per twenty-four hours and consequently would not record a leak less than this amount. In this case the consumption record showed an increased registration of only 500 cu. ft. for the first quarter of the new meter, but during the next period caught a leakage of 3000 cu. ft., which in all probability the meter removed would not have picked up. The record seems to show that the normal registration has been increased from 500 to 1000 cu. ft. per quarter by the change.

The third meter registered as low as 1000 gal. per twenty-four hours, and the meter that replaced it gained in one year about 1000 cu. ft. per quarter.

There are many causes contributing to the deterioration in effectiveness of the meter in

service—the gradual wearing of the working parts, clogging by foreign substances, such as white lead; scale from service pipes; dirt stirred up in the distribution system by reversal of flows; flushing of pipes; dirt getting in pipes when extensions or repairs are made. All of these have their effect on the domestic meters. This effect may be minimized by using care that little dirt gets in the pipes during construction, by flushing during periods when the house draft is at a minimum, by thoroughly flushing service pipes when new meters are set, by avoiding, in the installation of service pipes, the use of every material that will clog a meter, and by the selection of the best type of meter for particular services.

The bearing of several years of careful attention to domestic meters on revenue, as attested by the eight-year record of a residential town of about 24,000 population with 4200 meters in service in 1912, is enlightening. The town was completely metered in 1898, and between that time and 1906 no special care was given to the meters. In 1905 less than \$3 per capita was earned, and we began to give the meters more attention. The results obtained led us to study the subject carefully, and improvements continued until 1910, when our revenue touched \$3.66 per capita, a mark we hope to maintain. While we do not claim that the care of the meters was the only element entering into the raising of the gross revenue per capita, it was, in our opinion, the chief cause.

A comparison of the total registration of the domestic meters with the total quantity of water delivered to the town, as recorded by Venturi meters, has been made for 1904 and for every year since 1908. The ratio rose from 40 per cent in 1904 to 65 per cent in 1910, then falling off slightly, roughly paralleling the revenue curve. We are not at all proud of this record, but conditions are particularly hard, the distribution system being large in proportion to the population supplied and the pressure ranging as high as 130 lb. A portion of the system is under direct pumping and the pressures are raised for fire service. Like the revenue curve, the care of the meters was not the only influence that affected this result, as during this period considerable work was done in detecting and stopping leaks in the distribution system and service pipes.

Mortality Rates of Philadelphia in Relation to Water Supply

By John A. Vogleson, Chief, Bureau of Health, Philadelphia

Philadelphia was engaged in improving its water supply by construction of filtration plants and rearranging its water supply distribution system from 1900 to 1911. The typhoid fever rates of such districts as received filtered water in the early development of the improvements began to decline immediately after the introduction of filtered water, and following the completion of the last of the five filtration plants in 1911, the typhoid death rate for the entire city shows a consistent decrease from 72.4 per 100,000 in 1906 to 12.5 per 100,000 in 1912. Isolated sections of the city, notably West Philadelphia, with a population of 267,840, had a typhoid rate of 5.9 per 100,000 in 1912. A large percentage of the typhoid which formerly scourged Philadelphia was undoubtedly water borne, and the marked reduction of typhoid in this city is a notable sanitary achievement, due in by far the largest part to the filtration of the water supply.

The average total mortality rate for nine

years, 1862-70, was 2291 per 100,000 and consistently declined to an average rate of 1792 for the decade 1901-10, and still further declined to 1522 per 100,000 in 1912, the lowest record rate in the history of Philadelphia.

Operation of Torresdale Filter Plant at Philadelphia

By Francis D. West, Chemist in Charge, and Joseph S. V. Siddons, Superintendent

The Torresdale filter plant at Philadelphia receives water from the Delaware River and was placed in operation July 4, 1907. The main plant, as originally built, consisted of 65 $\frac{3}{4}$ -acre slow-sand beds, containing from 26 to 36 in. of sand of an effective size ranging from 0.25 to 0.35 mm and a uniformity coefficient of 2. There are 120 preliminary filter units of the mechanical type which operate without the use of a coagulant. These preliminary filters have removed over 60 per cent of the dirt in the raw water and have made it possible to double the output of the slow-sand filters, increasing the capacity from 110,000,000 gal. daily to 210,000,000 gal. daily. With pre-filtered water it has been possible to operate the slow-sand beds at a rate of 6,000,000 gal. per acre daily instead of 3,000,000 per acre daily. The lengths of run on the final beds have been doubled and the cost of filtration has been materially reduced by using prefilters.

Almost coincident with the starting of the prefilters was the introduction of the Nichols sand-washing machine, which, together with raking as an auxiliary, has practically superseded all other methods of cleaning at Torresdale. The machine consists merely of an inverted cylinder inside of a closed jacket. The dirty sand is fed in the usual manner and the wash water, the sand and dirt, instead of going out to the court, passes through the machine. The water strikes the side of the cylinder, the sand drops to the bottom and is allowed to pass through a nozzle and is spread on the filter. About 2 per cent of the fine sand is carried with the water and dirt to the court, where it is intercepted. The depth of cleaning with the machine may vary from a few inches to 8 or 10 inches.

The bacterial efficiency of the Torresdale plant for 1912 averaged 99.6 per cent.

A plant such as the one at Torresdale, without any sedimentation basins, is utterly unable to cope for any prolonged period with water having a turbidity of over 100 when operating the slow-sand filters at a rate of 6,000,000 gal. per acre daily. When such a condition is reached prefilters fail to do their proportion of the work. The final filters choke badly and allow fine silt to pass through them. This choking up necessitates cleaning for twenty-two hours a day, with from fifty-five to fifty-eight filter units doing the work of sixty-five, and depending upon hypochlorite to reduce the number of bacteria and destroy the pathogens. Fortunately the periods of turbid water occur but seldom and are of short duration. The pre-filters should be changed and operated like the coal filters at Steelton, or a sedimentation basin should be constructed and alum used to coagulate the water. Even during the very worst period the bacterial efficiency of the Torresdale plant averages over 99.5 per cent.

The filters cleaned by the Nichols methods during February, March and April have the longest runs, the length of run decreasing until about June and then remaining constant for the rest of the year. The runs with the Nichols method are longer than those obtained with any other. The average yields, in million gallons per acre, for the four years from 1909 to

1912 inclusive were 123, 195, 160 and 126. The longest run in the history of the plant was for 14 days, the quantity of water filtered being 569,000,000 gal.

Locating Leaks in Water Mains

By F. J. Hoxie Inspection Department, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

After exhausting the possibilities of aquaphones and other acoustic devices in locating a leak recently, the following alkaline solution method was developed and successfully applied, locating the leak within 6 ft. in a congested yard where to have dug up any considerable part of the pipe would have seriously interfered with the operation of the mill.

Caustic soda was selected because it gives a very sharp indication, is not particularly poisonous, and in the dilute solutions required

when the flow should be stopped and the meter again read. The difference in the readings represents the contents of the pipe between *D* and *E*; in the example, 294 gal. This divided by 1.47, the capacity of the pipe in gal. per foot, gives 200 ft., or the distance back along the pipe from *D* to *E*.

If the pipe is level or slants toward *D*, a point nearer *D* will probably be indicated, as the caustic solution is heavier than water and tends to flow downward under the water.

With a pipe sloping downward from the source of water to the leak, the indications will be unreliable. With one sloping upward, they will be accurate within the limits of the conditions of the experiment. Very frequently there is not one single leak but several, in which case find first the leak nearest *D*. After this is stopped, repeat the experiment, finding that next further away, and so on until all are found.

The phenolphthalein solution is formed by

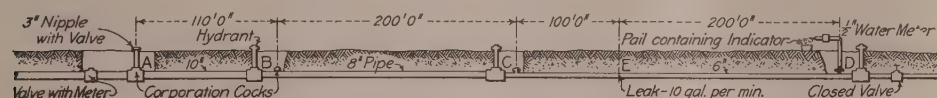


Diagram Indicating Method Used to Locate Leaks

Contents of pipe between A and B = $110 \times 4.08 = 449$ gal.
 Contents of pipe between B and C = $200 \times 2.62 = 524$ gal.
 C and E = $100 \times 1.47 = 147$ gal. E and D = $200 \times 1.47 = 294$ gal.
 Contents of pipe between C and D = $300 \times 1.47 = 441$ gal.

has no objectionable color, taste or smell and does no damage to pipes, gates or fittings. Carbonate of soda or soda ash will work equally well. The method can be used on public systems by taking the precaution to shut off the domestic connection while the measurements are being made, and flushing the pipes afterward.

After locating the leak within reasonable limits by use of section valves and meters its magnitude should be determined by placing a small meter around a closed valve.

Alkali is introduced into the piping at *A*, as near as possible to the source of supply. A $\frac{1}{2}$ -in. or $\frac{1}{4}$ -in. hole is tapped in the pipe and a corporation cock, *A*, attached. To this is affixed a 3-in. nipple about 18 in. long, with a reducing coupling and nipple at the lower end and a 3-in. valve at the upper end to prevent the water from flowing out. When in place the corporation cock is opened a small amount and the 3-in. nipple allowed to fill with water. Then 2 to 3 lb. of solid caustic soda or potash are placed in the nipple, the valve is closed and the corporation cock opened so that the caustic solution can diffuse into the pipe. The time that the corporation cock is opened is noted.

If a pump is used for supplying the pressure, great care must be taken that the valve from the primary supply is tight and that a steady pressure higher than the primary water supply is maintained; otherwise the air in the sprinkler system will cause false indication.

After the alkali has been in the pipe long enough to have arrived at *B* (449 gal. divided by 10 gal., or 44.9 minutes), a few spoonfuls of water are drawn from the cock at *B* in a pail containing half a teaspoonful of the phenolphthalein indicator. If the red color appears, this shows that all the leak is beyond. If the color should not appear, samples should be tested at minute intervals for 15 to 20 minutes. If a test is finally obtained, there are probably two or more leaks, part between *A* and *B* and part beyond. At the time calculated for the alkali to appear at *C*, tests as above should be repeated at *C*. Then at *D*, when it is found after waiting ten or fifteen minutes that the alkali has not appeared, a meter should be attached and read, and the water should be drawn off until red color appears in the pail,

dissolving the dry powder in the proportion of $\frac{1}{8}$ ounce to a pint of wood alcohol.

This method will not be found of much service for single leaks of less than 1 or 2 gal. per minute.

Hydrants and calibrated nozzles can be used instead of corporation cocks and meter for preliminary or approximate determinations. The results are not as accurate, however, and leaky hydrant drips may give trouble.

New Cyclopean Masonry Dam at Pittsfield

By Hiram A. Miller, Consulting Engineer, Boston

The new Farnham dam which has been built to furnish an additional water supply to Pittsfield, Mass., has a gravity section of cyclopean masonry, about 600 ft. in length, with core walls at each end, making the total length of the dam about 900 ft. It is divided by expansion joints with inspection wells passing down through the joints, near the upstream side, to the bottom of the dam. These inspection wells are connected at the bottom by cast-iron drainage pipes, with a pipe leading from the bottom of the deepest well to the westerly side of the lower end of the spillway.

The gate well is on the upstream side of the dam outside the regular section, and is about 10 ft. square, having four inlets at various elevations.

The expansion joints are 80 ft. apart, having 6-in. vertical offsets, 8 ft. apart through the dam. There is a copper strip across the joints on the upstream side of the inspection well similar to the one designed by the engineers of the Board of Water Supply of New York City for the Kensico dam. One side of the expansion joint is constructed of concrete blocks; on the other side the concrete of the cyclopean masonry is permitted to come to the joint. Before laying the concrete the side of the joint first constructed was coated with hot tar pitch, then a sheet of roofing paper was applied to the hot pitch, and the roofing paper was again coated with hot pitch.

During the last of February of the present year, after the coldest spell of the winter, when the reservoir was full, the total leakage through the joints measured at the end of the drainage

pipe was at the rate of 18,000 gal. per day, which had decreased during the present summer to 200 gal. per day when the reservoir was drawn down 11 or 12 ft. Moisture appears on the downstream side of the dam to the extent that a large proportion of the area appears wet on a damp morning, but in the sunshiny afternoon the surface is mainly dry.

In the revised pressure diagram, made since the completion of the dam, the weight of the masonry is taken as 157 lb. per cubic foot, the volume of the inspection wells being included in the volume of the dam, the weight of the quartzite being 169 lb., and the weight of the schist 174 lb. The weight of the concrete was averaged at 151.2 lb. Ice pressure was taken at 10,000 lb. per linear foot at the surface of the water. It was assumed that the upward pressure of water under the dam would be equal to the full pressure of the water at the upstream side, and that it would be nothing at three-quarters of the distance from the upstream side to the downstream side, either at the bottom of the dam or at any horizontal section of the masonry. When the reservoir is empty the pressure line passes about 3 in. outside of the middle third, but if the deduction for the inspection wells had been taken out of the vertical longitudinal section in which they are, instead of being distributed through the total volume of the dam, and if the lesser weight of the masonry near the upstream face of the dam, being all concrete, had been taken into account, this pressure line would not have passed outside the middle third. The pressure will keep within the middle third, in accordance with the above assumptions, when the reservoir is full to the elevation of the spillway. It will also keep within the middle third with the water 5 ft. higher, provided there is no ice pressure. Consequently flashboards 5 ft. high can be safely placed across the spillway, provided they are removed before ice forms on the surface of the reservoir to any great thickness; and provided also that there is no depth of water passing over the spillway.

Portable Irrigation Pumping Plant

A 20-in. Dow centrifugal pump belted to a 100-hp. Westinghouse induction motor and mounted on a barge is used by the Moulton Irrigated Land Company for delivering water to rice fields along the Sacramento River, California. As the barge is towed from point to point by a gasoline launch, it is able to accomplish what would otherwise require four stationary plants. Power is obtained at the four pumping stations from the 11,000-volt transmission line of the Pacific Gas & Electric Company. A bank of transformers on the barge steps down this tension to 440 volts as used by the motor.

About 16,000 gal. per minute are handled by the pumps, and as the head varies from 12 to 23 ft. with the river stages the motor is about 30 per cent overloaded when the river is at its lowest point. So far, it is reported, no trouble due to this overload has been experienced. The outfit is operated almost continuously from the latter part of April to the end of August, being shut down only when the barge is towed from one point to another.

A HIGHWAY TUNNEL is planned to be built by the city of Venice in Italy. It will be 11,800 ft. long and will be the largest of its kind. The idea is to connect the city with the islands Gindicca, San Giorgio and Lido, thus establishing better transportation facilities than are afforded by gondolas. A sum of \$20,000 has been granted to the investigation committee.

Specifications for Maps and Profiles for Federal Valuation of Railroads

Objections by Carriers to Tentative Stipulations by Interstate Commerce Commission, with Proposed Amendments and General Suggestions

Strenuous objection is made by the carriers of the United States to certain features of the tentative draft of specifications for maps and profiles as prescribed by the Interstate Commerce Commission in connection with the Federal valuation. The three main objections are to the preparation of new plans where old ones would serve the purpose, to the furnishing of sundry information not available without new surveys, and to the surrendering by the carriers of the tracings instead of blueprints or negatives.

PROVISIONS OF SPECIFICATIONS

The specifications as drafted require the railroads to file with the commission three classes of tracings, as follows: (1) Right-of-way and track maps, on a 400-ft. scale, showing right-of-way, track and structures; (2) station maps on a 100-ft. scale for sections where the information required cannot be clearly shown on the smaller-scale maps; and (3) profiles, on scales of 20 and 400 ft., vertically and horizontally respectively. For large cities and towns the station maps are to be divided into two sets, one showing land details only and the other showing track and structures with the principal land boundaries. The prescribed length of all tracings is 56 in., the maps to be 24 in. wide and the profiles 12 in.

On the maps showing right-of-way in detail the specifications require a complete schedule of the grantor, grantee, record of deed and similar information on each separate parcel acquired; also the property lines of adjacent landowners; section and quarter-section lines for 1 mile either side of the railroad center line, as well as such subdivisions, streets, lots, etc., as can be shown without new surveys; lengths of all side tracks, and outlines, where they can be shown clearly, of all improvements. Stationing from left to right is called for, except where this would clash with established stationing; in that event such platting may be used as will preserve this established stationing, provided the maps are continuous in the same direction between the termini of the main line or branch in question. On the profiles an alignment diagram is prescribed, and the individual sheets must correspond with the individual maps. The profiles must also show tabulated quantities of all materials for each mile of road.

Other stipulations relate to character of tracing cloth and ink used, border lines, symbols, lettering, arrangement of data, cardinal points, indexing, titles and certification.

GENERAL OBJECTION

In its criticism of the tentative draft of specifications the Presidents' Conference Committee of the principal carriers throughout the country, through its committee of engineers, objects primarily to the adoption of any specifications until the Interstate Commerce Commission shall have examined the existing maps, profiles and plans of the carriers to learn what additional ones, if any, should be furnished. The carriers believe they should not be obliged to duplicate existing maps or other records which are reasonably sufficient for the purpose of ascertaining values, whether or not such maps or other records conform to the specified standards. They aver that literal

compliance with the tentative specifications would require an indeterminately long period of time, thereby delaying indefinitely the work of valuation.

The carriers further submit that until a complete method of valuation has been determined upon, a system of gathering and filing data with a complete index map thereof worked out, and the requirements that will be made by the commission in the reporting of additions and betterments ascertained and fixed, the tentative draft of specifications cannot be finally discussed. They feel that they should not be burdened with the expense of furnishing anything not necessary to the investigation and determination of values, and that they should not bear the cost of preparing and maintaining the records and files of the commission in support of the valuation. They state that for the tracings alone the cost would be \$20 per mile more than that for furnishing prints from existing tracings.

Considering all of these points, the carriers believe that the only part of the tentative draft that should be adopted at present is a paragraph of a footnote that reads as follows: "To enable the engineering board to begin the valuation work promptly, the carriers shall furnish copies of those existing maps and profiles and other standard and special plans that will assist the engineering board in its work. These existing maps, profiles and other plans shall be collected together by the carriers at their general engineering offices for inspection by the engineering board or its agents, and copies of such maps, profiles and other plans which this board determines useful for its purpose shall be furnished when requested."

FURNISHING OF TRACINGS

To the furnishing of tracings at any time the carriers positively object. The advantages for the purposes of the commission they state to be permanency, ease of reproduction and ability to correct. Against these they set the disadvantages of excessive and unnecessary cost, probability of error and omission, and undesirability of the commission changing basic maps or attempting to keep them up to date. Discussing these points more fully, the carriers assert that they can make prints almost indefinitely permanent, and that they stand ready to supply negatives with the prints, so that the commission can produce as many prints as desired, using dry processes that will eliminate scale distortion. As to the ability to correct tracings, the carriers aver that long experience in attempting to keep two sets of maps up to date (as in chief engineers' and division engineers' offices) has shown that this is not readily done, and that as the railroads must keep up-to-date maps it is entirely practicable to furnish the commission with prints whenever radical changes are made. This procedure, they say, will avoid liability of error and will save the commission forces much work and responsibility in changing basic maps. Considering these points, the carriers think the excessive cost of supplying tracings would be unwarranted.

Three principal changes in the general scheme for the drawings are recommended by the carriers. For convenience and economy,

and to avoid duplication of work, they would have the profiles included on the right-of-way and track maps, increasing the widths of these maps to 30 in. instead of 24 in. This would automatically do away with the separate alignment diagram, and the carriers would further eliminate the tabulated statement of quantities for each mile of road, which they claim could not be clearly or properly placed on the profile or map, and should be in an inventory. They also propose a separate schedule of matters pertaining to the acquisition of the right-of-way, instead of including this information on the maps.

The carriers object to any requirement being put on them to furnish the boundaries of or information concerning adjacent lands or the names of the owners thereof. They point out that they have no right to enter upon such lands to make surveys, and that the names of the owners, particularly in cities, are numerous and difficult to obtain, and they further contend that such names if obtained would be of no value because of the constantly changing ownership.

MODIFIED DRAFT

In the event that the commission overrules the general objections to the adoption of any order other than the one embodied in the footnote paragraph quoted in full, the carriers ask permission to state somewhat in detail sundry objections to the tentative draft of specifications not already enumerated, and to this end they submit a modified draft. This modified draft embodies all of the objections already cited, with special emphasis on the desirability of making new tracings only when adequate existing ones are not available, and of allowing the carriers to retain all tracings. The various stipulations would, therefore, only apply to entirely new maps.

Among the additional changes proposed are the following: The scales for the maps are not positively prescribed, but are not to be smaller than those named in the tentative draft. For the profiles the vertical scale may be either 20 ft. or 30 ft. to the inch. Any plain and simple lettering may be used, instead of gothic, as prescribed by the commission. Cardinal points need only be indicated "as nearly as can be ascertained from existing records," and such phrases as "if available" or "if feasible" are appended in a number of places. Changes in the methods of indexing are proposed, mainly to conform to accepted railroad practice. Instead of certifying to the correctness of each sheet, the carriers would certify only the last of each series, each of the other sheets of the series to be identified by the signature of the officer authorized to certify records.

In conclusion the carriers ask permission to state orally and in detail the reasons which support their objections and suggestions, and that—unless all of their statements of fact be taken to be true by the commission—each carrier, by order of the commission, be given opportunity to introduce evidence in support of such statements, and especially to exhibit to the commission its existing maps and profiles, which it thinks substantially meet the requirements of the work of valuation.

A TIMBER-SALE of 700,000,000 ft., b. m., in the Kootenai National Forest, which is near Montana's Canadian boundary, is announced by the Forest Service. It is planned to make paper pulp of the wood. It is estimated that the Government will receive \$1,500,000 for the timber; \$500,000 of this sum will go to Montana for schools and roads.

AMERICAN PUBLIC HEALTH ASSOCIATION CONVENTION

Abstracts of Some of the Papers and Committee Reports Presented
before the Laboratory and Sanitary Engineering Sections of the
Forty-first Annual Meeting at Colorado Springs, September 9 to 13

Sanitary Control of Waterways

Committee Report by George C. Whipple, Chairman; Paul Hansen, Andrew J. Provost, Theodore Horton, Harrison P. Eddy

The term "sanitary control of waterways" is preferable to "river cleaning." It is recommended this committee be known henceforth as the "Committee on the Sanitary Control of Waterways."

Where it is only necessary to prevent a nuisance, and the waterway has no other practical use than that of an open drainage course, no greater requirement need be made than that the water be non-putrescible, free from unsightly color and suspended, or floating, matter, and that no sludge banks or other objectionable deposits be formed. As a measure of such pollution a knowledge of the physical characteristics of the polluting matter and the diluting water, such as color and suspended solids, together with a knowledge of its biological character, as shown by the oxygen-absorbing power, would be of greatest service. Such a measure has recently been proposed by the Royal Commission on Sewage Disposal in England, and standards of this kind have been proposed for New York Harbor by the Metropolitan Sewerage Commission.

When a standard for the permissible degree of pollution in waterways used as sources of public-water supply is established it ought obviously to rest not upon analyses alone, but quite as much upon the sanitary conditions of the watershed—knowledge of stream flow at high and low water, the population and industries tributary to the sewers, the distance of pollution above the waterworks intake, and the like. In other words, some index must be obtained of the danger of infection.

The use of waterways for recreation purposes places a great demand upon the purity of the water. In establishing sanitary standards for this class of waters aesthetic consideration must play a predominant part. The water must appear to be clean and there must be no sewage or wastes discharged into it that will prejudicially affect the appearance or odor of the water even in the immediate vicinity of the sewer or waste outlets.

Where injury to fish or shellfish occurs the permissible degree of pollution in a waterway is an essentially economic proposition, to be decided after a comparison of the damage done or expected and the cost of preventing the damage.

The question of the danger to cattle from drinking from polluted water courses should also be settled upon economic grounds.

Injury to industries by waterway pollution is another question to be considered on a strictly economic basis; the cost of preventing the pollution and the damage that accrues to the industries from such pollution must be compared. The means for measuring pollution in such cases must vary with the character of the industries affected, and no general rules may be laid down.

The obstruction of channels by solid matter rarely results from sewage discharge, but may

result in marked degree from certain industrial operations, such as hydraulic stripping of quarries and sluicing operations. An element that may enter at times is the danger that floods may result from undue restriction of waterways by heavy deposits of wastes.

In approaching the solution of any problem involving waterway sanitation the question should invariably be asked "What is the value of the benefits derived as compared with the cost of maintaining the stream in an acceptably clean condition?" Broad generalizing must be avoided, for nearly every waterway is a law unto itself.

Water Purification

Report of Committee Consisting of George W. Fuller, Chairman; F. E. Longley, Charles G. Hyde, G. G. Earl, Morris Knowles and J. L. Ludlow

A table was presented before the International Congress of Hygiene and Demography in Washington in 1912 by Mr. Allen Hazen, giving the population supplied with filtered water for several decades, and to which figures for the current year have been added.

POPULATION SUPPLIED WITH FILTERED WATER

Year	Population	Year	Population
1870.....	None	1900.....	1,860,000
1880.....	30,000	1910.....	10,806,000
1890.....	310,000	1913.....	13,290,000

During the period 1904 to 1913 works were built for supplying filtered water to the following cities of 100,000 population or over: Philadelphia, Pa.; Pittsburgh, Pa.; Washington, D. C.; Indianapolis, Ind.; Providence, R. I.; Cincinnati, Ohio; New Orleans, La.; Hackensack, etc., N. J.; Louisville, Ky.; Columbus, Ohio; Toledo, Ohio; Atlanta, Ga.; Birmingham, Ala.; Scranton, Pa.; New York, partial; Minneapolis, Minn., and Grand Rapids, Mich.

A number of cities in Canada have also, within the last few years, built or are building water filtration plants. Among these are Montreal, Toronto and Saskatoon. Steps have also been taken in the direction of water filtration plants at Ottawa, Hamilton and Brandon.

A number of cities in the United States have in the last year or so either placed contracts for or have been seriously considering filtration plants, the principal ones of which are New York City (Boroughs of Manhattan and the Bronx); Hartford, Conn.; Baltimore, Md.; St. Louis, Mo.; Trenton, N. J.; Erie, Pa.; Decatur, Ill.; Dallas, Tex.; Akron, Ohio; Quincy, Ill.; Evanston, Ill., and New Brunswick, N. J.

The question has been agitated at numerous other places, the chief cities being those on the Great Lakes, including Milwaukee, Cleveland and Detroit.

PROGRESS AND LIMITATIONS OF STERILIZING PROCESSES

Hypochlorite.—Where a municipal water supply is subjected to treatment of any kind the use of hypochlorite is almost always a part

of that treatment. It is a very cheap and quite effective method, generally speaking, for destroying certain of the dangerous elements of a polluted water supply.

The hypochlorite treatment has well-defined limitations. It does not remove turbidity nor color, nor organic matter to any appreciable extent; nor does it remove objectionable tastes or odors. Suspended matter in the water interferes seriously with the efficiency of the treatment. The treatment fails to destroy certain kinds of bacteria which are very resistant to the toxic effect of the chemical. There is considerable evidence, too, to indicate that this treatment, as applied in the United States, does not actually destroy all of the bacteria, but simply stuns them or drugs them for a time.

That hypochlorite has a disagreeable taste and odor is, of course, commonly known. The quantity in which it has to be applied to produce the desired effect in a polluted water is very small, ordinarily small enough so that it does not impart any of this taste or odor to the water treated. Every water, however, has its own limitations in this respect, and experience with a number of waters has shown that practical difficulties sometimes arise in producing the effect desired without leaving the water with seriously objectionable qualities. Treatments have been developed and applied which are designed to remedy such offensive tastes and odors, but are not yet generally used, for the reason probably that they are not frequently needed.

Hypochlorite treatment must not be considered as a substitute for other established means of water purification. It is valuable indeed in many emergencies, and valuable always as an adjunct to filtration. In some waters which are unusual in their freedom from suspended and organic matter it may be considered all-sufficient, but the principal applicability of the treatment is for emergency use or as a finishing process after filtration.

Liquid Chlorine.—The use of liquid chlorine as a sterilizing agent has recently come to public notice. At the present writing its use has not become general enough to afford decisive evidence that it will have the same practical success that the hypochlorite treatment has had. Its advocates make very promising claims for it, and the little evidence that has been presented to the public indicates it is worthy of careful consideration and study. It is said to be quite as efficient, if not more so, than hypochlorite, and so far as the chemical itself is concerned is also said to be more economical.

Ozone.—Under proper conditions ozone has the power to completely destroy bacterial life in water. The commercial application of ozone, however, is attended with certain difficulties. Principal among these is the difficulty of obtaining a thorough and intimate mixture of the ozone gas with the water to be treated, to be sure that a suitable amount of the gas comes in contact with every particle of water, and of the interruptions in the continuity of performance of the ozonizer. Another difficulty seems to have been the high

cost of the treatment when compared with the modest cost of hypochlorite. The treatment is not applicable to water which contains turbidity or organic matter.

Ultra-Violet Rays.—Somewhat the same remarks may be made about the use of ultra-violet rays for the sterilization of water as those given above regarding ozone. Its use has been advocated and its success, on a laboratory scale, has been well demonstrated, but its excessive cost, its complicated nature and the difficulty of making it applicable to the treatment of large volumes of water, together with the other general limitations already referred to, do not at present promise well for its commercial success.

At Springfield, Mass., it was discovered that the desired decolorizing effect could be produced with entire satisfaction by dosing the water intermittently with aluminum sulphate, applied as the water enters the sedimentation basin. This continues for several hours, the water thus treated mixing with the water previously contained in the basin. During seven months of 1912 an average application of 0.23 grain per gallon of aluminum sulphate reduced the color from an average of 37 in the raw water to 15 in the filtered water. It is believed that two factors contribute to the success of this intermittent treatment under Springfield conditions. First, the water is very soft, having an alkalinity which averages hardly more than 10 parts per million. Second, the sedimentation basin, in which the mixing of the coagulated and uncoagulated waters takes place, has a capacity much greater than is commonly found in coagulating basins of mechanical filter plants, namely, about 40,000,000 gal. per day for an average daily flow of slightly more than 10,000,000 gal. This gives ample time for the reactions which result in the discharge of the color.

DECOLORIZATION AND WATER SOFTENING

During the past year the water softening plant at Grand Rapids, Mich., has been put in service. It deals with a highly colored and moderately turbid water having a total hardness of about 250 parts per million. The incrustants or permanent hardness amounts to only about 30 parts per million.

The most interesting feature of the Grand Rapids project is that the lime which is used for softening the water also succeeds, through the removal of magnesia, in reducing the vegetable stain to a point as low as that which could be secured at much greater expense by the application of sulphate of alumina. In other words, a highly colored water that is hard is reduced in color to less than 10 parts per million with the use of lime, and its total hardness is reduced to less than 100 parts, all at a cost of less than would be required for treatment with sulphate of alumina to secure equal decolorization.

Lime or soda to remove free carbonic acid and thus reduce the corrosive tendencies of the water, if judiciously applied, seems capable from laboratory experiences with the Croton water of New York City of forming coatings on the inside of a pipe system so that corrosion may be practically neglected.

Clear underground waters and filtered surface waters show an amount of iron dissolved from the piping which is probably no greater than that in many turbid and colored surface waters. But when the latter are used in an untreated condition the effect of corrosion seems to have been largely obscured by other physical characteristics. Hence the rapid increase in the use of filtered water has developed the need for additional care in the study of filtration projects.

Rational Basis for Sanitation of Rivers and Harbors

By George A. Soper, President Metropolitan Sewerage Commission, New York City

A rational basis for the sanitation of rivers and harbors can be arrived at only by the careful consideration of what is both desirable and practicable in the way of protection from sewage. The extent to which protection is afforded should depend upon the uses to which the natural body of water is put. Boards of health frequently err on the side of too stringent requirements and municipalities frequently make the mistake of waiting until a river becomes excessively foul before attempting to devise a sanitary disposition of the sewage. Each case must be dealt with in accordance with a clear understanding of its particular requirements.

The sanitation of rivers and harbors, like street cleaning, should be essentially preventive work. It is desirable that a definite standard of cleanness be established at the outset to serve as a guide for all future operations. Due consideration should be given to the practical side of the question. The art of disposing of sewage in a sanitary manner does not make it possible to keep waters in a scrupulously pure state without excessive cost, and sewage-purification works are themselves frequently a cause of nuisance.

In order to obtain a rational basis for the sanitation of rivers and harbors a distinct program for the construction of the necessary sewage-disposal works should be made out long in advance of the requirements and should be followed as the circumstances of the situation demand.

Shellfish Conservation and Sewage Disposal

By George A. Johnson, Consulting Engineer, New York City

The shellfish industry has grown until the value of the total output of nearly 40,000,000 bushels amounts approximately to \$20,000,000, three-fourths of which is controlled by New York, Virginia, Connecticut, Maryland, New Jersey, Rhode Island, Louisiana and Massachusetts. Sanitary conditions naturally have changed also. Where shellfish formerly grew in a naturally pure state there now often discharge huge sewer outfalls, polluted rivers or the effluents of sewage-treatment works.

There can be no question that the oyster will take in and retain pathogenic germs. Although typhoid germs do not multiply within the body of a healthy oyster but decrease, there is evidence that in dead oysters this germ will actually flourish. Thus it is easily conceivable that one dead oyster may contaminate scores of perfectly good oysters growing in the same vicinity or stored in the same receptacle. It is equally certain that polluted oysters repeatedly have caused epidemics of typhoid fever and other intestinal disorders.

Of recent years we hear much of the possibilities of "oyster hibernation." The theory is that during the cold months of the year the shell closes tightly and the oyster passes into a "sleeping" state, to open and resume its normal functions with the advent of warm weather. Hence oysters dredged in the cold months supposedly are safer to eat than in the warm months.

Heat, as ordinarily applied in cooking shellfish, does not destroy all of the germs they may contain, for to do so would be to impart to them the consistency of rubber.

Until all sewage is made innocuous before discharge there seems to be little hope that shellfish will be considered other than a potentially dangerous article of diet, unless perhaps they are allowed a period for self-purging in unpolluted water before being placed on the market. It seems reasonably certain that polluted shellfish when placed in constantly changing unpolluted water will purge themselves of impurities in from one to two weeks. This refinement in the preparation of shellfish for the market may not be the ultimate answer to the problem, but it deserves exhaustive study.

Except in special well-adapted cases, it is impossible on financial and other grounds absolutely to conserve the purity of shellfish layings by sewage treatment. Complete treatment of the sewage entering waters which flow over shellfish layings will improve existing conditions, and in special cases almost, if not indeed entirely, remove the existing danger; but to be thoroughly effective unusual conditions and extreme conscientiousness in the operation of the sewage-treatment works are required, paralleling the vigilance with which good water-filtration works are watched. Interstate co-operation, the whole order of affairs being supervised by a supreme authority vested by law with power to approve or condemn, would also be necessary.

The conservation of the shellfish industry is a difficult problem, made so by the fact that common-law rights of sewage disposal into the sea and its estuaries have been and are being extensively utilized. To set these conditions back a century solely for the sake of conserving the oyster industry, where no other offense is created, is a matter which, if pressed, will engage active sanitary, financial and legal minds for many years to come.

Water Softening and Decolorization

By Walter A. Sperry, Chief Chemist, Board of Public Works, Grand Rapids, Michigan

The distinctive problem at the Grand Rapids filtration plant has proved to be the removal of the effects of the steeping of the meadows in water that reached the Grand River. The problem was rendered more difficult in that in addition to its color the water was hard, and hard waters seem more difficult to decolorize than soft waters, provided there is an absence of clay.

The total hardness of the water at Grand Rapids, in parts per million, has averaged 217, with a maximum of 288 and a minimum of 104. This has been accompanied by an average color of 32 and an average turbidity of 20—the color ranging from 16 to 55 and the turbidity from 5 to 135 parts per million as minima and maxima. This total hardness was made up of the bicarbonates of calcium and magnesia, averaging 188 parts per million, accompanied by about 30 parts of sulphates and an average of 17 parts of magnesium for the past six months.

The first few days of operation showed that the amount of alum necessary to produce a water whose color was 10 parts per million or less was excessive—a water carrying a color of 30 to 40 parts requiring 3 to 4½ grains per gallon of alum to produce a water of the above requirements. Such treatment was not only expensive, but so increased the sulphate or permanent hardness as to produce a very disagreeably hard water. Meantime laboratory experiments indicated that the use of lime would not only soften the water, but decolorize it as well, and at less expense.

It was proposed to utilize the magnesium in the Grand River water supply through the

softening process as a decolorizing agent. By the addition of lime sufficient for the full neutralization of the bicarbonates present it was found that we could produce a water whose color was 10 or less and whose total hardness ranged from 88 to 100 parts per million. By so doing we were able to reduce the alum required to an amount as low as $\frac{1}{4}$ grain per gallon, its function being largely to help carry down the fine crystals of calcium carbonate formed in the softening process. The use of lime offered as advantages the reduction of both hardness and color at greatly reduced cost as compared with alum.

This method of treatment with lime has proved most efficient and economical for all classes of waters the seasons have brought to our plant.

A Fallacy of the Methylene-Blue Putrescibility Test

By Dr. Arthur Lederer, Chemist, The Sanitary District of Chicago

Widely differing results can be obtained by varying the quantity of methylene blue in tests for putrescibility. The results of my investigations were so striking as to clearly call for an adjustment of the point in question if the test is to be retained as a fairly accurate expression of the relative oxygen requirements of a sewage, effluent, or contaminated water. Tests brought out clearly the fact that the relation of the concentration of the dye to the bottle capacity is of great importance.

Experiments with various mixtures of sprinkling filter effluent indicate that relative stabilities of 1.0 cu. cm. and 0.70 cu. cm. of the methylene blue solution are used, yet the "standard methods" of the association permit such variations. The variations become more marked with the variation in the amount of coloring matter employed.

The question arises: "How much of the methylene blue should we add to make the test indicate the elimination of the nitrate and nitrate oxygen without influencing the time element through any germicidal action of the dye?" For this purpose a series of tests was arranged in which the time of decolorization was recorded on one and the same sewage mixture, when different quantities of the coloring matter were employed. A series of bottles containing the same sewage mixture, without dye, however, were likewise incubated at 20 deg. C. and the nitrates as well as nitrites determined in one of the "blank" bottles whenever the blue color disappeared in one of the putrescibility bottles. In this way it was deemed possible to come fairly close to the actual amount of dye indicating the elimination of the available oxygen. The initial mineral nitrogen (nitrate-nitrite-oxygen) varied as a rule from 1 to 5 parts per million. I believe that the results point to the conclusion that if 0.4 cu. cm. of the methylene blue solution is used the mineral nitrogen at the time of decolorization has practically disappeared. The shorter time required by the use of 0.3 cu. cm. of the coloring matter does permit the retention of larger quantities of the nitrate-nitrite oxygen. It is also noteworthy that a certain small residual mineral nitrogen is left even if the time of exposure be extended beyond the time occupied by the decolorization of 1.0 cu. cm. of the methylene blue. For all practical purposes such a small quantity is immaterial since the oxygen available from it is likewise extremely small.

It must be conceded that the observations recorded hold good only for the brands of the dye employed by me. It is possible that other

brands vary in their germicidal properties. In the light of my observations, this is a factor of great importance if the interpretations of the results obtained with this method are to be of service. All of the "relative stability" figures obtained lately in the laboratory and field work of the Sanitary District of Chicago are based upon the 20-deg. C. incubation in 150 cu. cm. bottles containing 0.40 cu. cm. of a 0.50 per cent aqueous methylene blue solution (Weiler-ter Meer Company).

In view of the importance of the test, I would recommend that the committee of the American Public Health Association on methods for the chemical analysis of water and sewage investigate the matter. The concentrations of the methylene blue solution permitted by the "standard methods of water analysis" at present are undoubtedly too high. Only one definite concentration should be made "standard."

Progress in Street Cleaning

By S. Whinery, Consulting Engineer, New York City

There have been no radical or particularly notable advancements during the last few years in the machinery and methods of street cleaning in American cities. But no little progress has been made in improvements on methods and appliances and in a more careful study and analysis of the business, especially with reference to detailed cost of the work.

Since the advent of street-flushing wagons and horsepower squeegees little that is new or novel in street-cleaning machinery or appliances has come into use. The flood of patents issued for street-cleaning devices continues unabated, but these patents relate largely to details and disclose little of value for practical use. Most of our street-cleaning apparatus is admitted to be more or less crude and unsatisfactory, and there would seem to be possibilities for material improvements, if not radical innovations. The operation of the present street-cleaning machines by mechanical power, as tried in many cities, involves such practical difficulties that its successful use is somewhat problematical, though there seems to be a useful field for it in the collection and transportation of street sweepings, especially where the haul is long. Vacuum or suction machines for collecting street dirt, if perfected to do the work satisfactorily and economically, would have the great advantage of removing the dust from the street without resorting to the use of large quantities of water.

A decided advance in the standards of cleanliness of streets has been manifested within recent years. In the smaller cities and suburban sections, where earth and broken-stone street surfaces prevail, the use of oil to suppress dust is now quite general. While this is not, strictly speaking, a street-cleaning process, it serves as an effective temporary substitute for cleaning and marks a revolutionary improvement in the comfort of using such streets.

Perhaps the most promising advance that has been made is the greater attention given the keeping and analysis of more complete and itemized accounts. This requires, of course, greater attention to the collection of exact data of quantities and costs and involves no little additional expense, but it is becoming more and more appreciated that the money so spent is wisely invested. There is growing up a strong demand for the general adoption of a uniform system of accounting and for more complete and detailed printed reports of street-cleaning departments.

Street littering is effectively prevented in most European cities by the rigorous enforcement of laws or ordinances prohibiting it. Most of our American cities have such laws and ordinances, but they are practically "dead letters." Spasmodic attempts have been made to enforce them in a number of cities, but public opinion has not sufficiently sustained these efforts, nor have the municipal authorities, as a rule, made their enforcement practicable by providing an ample supply of receptacles into which such litter may be deposited. It is hoped that the time is not far distant when the necessary receptacles for litter may be generally provided by the municipalities and ordinances against street littering will be rigidly enforced. In New York City the street cleaning department has estimated that the additional cost for collecting street litter is \$270,000 annually. This very large sum could be saved to the city by providing convenient receptacles for litter and then enforcing the ample ordinances already existing. European experience has proved beyond doubt that this may be done without imposing any serious inconvenience on the public.

The possible utilization of street sweepings for filling low lands or building up new and very valuable areas of land by filling in shore areas now covered by shallow water is receiving attention. Contrary to the prevailing opinion, experience and investigation have demonstrated that street cleanings free from garbage may, if properly handled in the dumps, be so used without danger to the public health and without serious inconvenience or offense to the public.

Some satisfactory method probably will be discovered to recover at a profit the fertilizing elements of sweepings and refuse from paved streets.

In snow-removal work the old and well-known methods and appliances continue to be used. Doubtless new and efficient machinery for the work could be devised, but the cost of installing it and the very short time it could be utilized make it very questionable whether in the end it would prove a good investment. Theoretically it is not impracticable to design apparatus to melt the snow on the street at a cost below that of loading it upon the wagons and hauling it away, but, when it is considered that such apparatus could be operated for only a few days during the year, the cost of providing it would probably not be warranted.

20 and 37 Degree Plate Counts for Bacteria

By J. Bosley Thomas and Edgar A. Sandman, Water Department, Baltimore

The widespread objection to the change from the standard temperature of 20 deg. C. for incubating plates for bacterial counts to 37 deg. C. has led us to run our routine counts at both temperatures for a year. For the purpose of this paper the results of daily examination of samples of water from three moderately polluted streams, flowing through essentially the same kind of rural district, and discharging from 10,000,000 to 100,000,000 gal. per day, were selected.

The average of the 37 deg. temperature counts is 322, and the average of the 20 deg. counts is 2867, which is about ten times the 37 deg. average. Several methods of grouping the results were considered, but the following scheme of comparing the counts with the probable character of the water and yet keeping the table as condensed as possible was de-

cided upon: Each sample having been subjected to examination in pure culture for members of the B. coli group, the counts at both temperatures were grouped according to whether the sample had shown the presence of one or more members of the B. coli group in 0.01, 0.1, 1 and 10 cu. cm., and further separated into the number of times they came within certain limits. The tests for members of the B. coli group included the use of dulcitol, in addition to the three usual sugars, appearance of growth on gelatin, and other special tests after rejuvenation when the original results were not sufficiently characteristic.

A striking fact brought out by this method of grouping is that the averages at both temperatures increase in geometric progression as the B. coli group organisms were isolated from 10, 1 and 0.1 cu. cm. This does not hold good, however, with the counts grouped under B. coli present in 0.01 cu. cm., where the small number of counts probably materially influences the average.

The use of the two temperatures for examining waters disinfected with calcium hypochlorite has shown that the organisms growing at 37 deg. are more resistive to the treatment than the organisms growing at the lower temperature, and that the higher temperature seldom shows the presence of after-growths.

If there be any advantage of one count over the other as an index of pollution it is perhaps slightly in favor of the higher temperature, the counts at which show less variation within the limits of the counts.

Municipal versus Contract Street Cleaning in Washington

By J. W. Paxton, Superintendent of Street Cleaning, Washington, D. C.

Street cleaning by city labor in Washington, D. C., superseded the contract system on July 1, 1911. Notwithstanding the changes in methods and the first cost of new equipment, the expenses for the first year were lower than those for the years when the work was done by contract. At the end of the second year, June 30, 1913, the records disclosed that for the expenditure of the same amount of money more than 25 per cent more work was accomplished than during the last year of the contract system.

Under the contract system in Washington changes in specifications and methods of doing the work took place very slowly, and usually only when specifications were made up for new contracts, which was once in five years; but in the municipal work of the last two years improvements have been of daily occurrence. Each blockmen's work has been studied individually. Time studies with odometers have been made of all vehicular movement. Collections are all made working toward the dumps. Schedules are arranged for all machines, squeegees, flushers, etc., so as to do effective work every moment from the time they leave the stable until their return. Each gang is arranged with the view of having the number of sprinklers, machines, brooms, shovels and carts in proper proportion. It has been found that some of the wider alleys can be swept to advantage with one-horse brooms, and schedules have been very carefully worked out to do the work with as little loss of time as possible in going from one alley to another.

The area of each square, intersection and alley has been carefully computed and card-indexed, and a cost-keeping system has been established which assists in comparing the cost of cleaning 1000 sq. yd. each month or oftener with the cost in previous months, or one

foreman's work with that of another doing similar work, or one method of cleaning with another. The office is supplied with a multigraph printing machine, so that schedules may be changed and reprinted on a day's notice.

The most radical change in methods has been to increase the hand-cleaning combined with an occasional washing and to decrease the machine-broom areas. The machine brooms raise so much dust that heavy sprinkling is required; the fine dust mixes with the water to form a fine mud, which is smeared on the street by the broom, and, becoming dry, turns to dust again. The brooms only sweep the coarser particles, and many of these are thrown by centrifugal force over the broom back to the pavement.

Hand-cleaning work is capable of better distribution than any other method, more attention being given to the dirtier areas by simply increasing the number of men, who only clean the portions of the street which are dirty and work on these portions until they are clean. There is a fine scum which becomes plastered to the pavements, particularly sheet asphalt, which is not apparent when the pavements are dry but rises up in a thin sheet of mud when moist, making the pavements very slippery. This and fine dust cannot be removed by the hand cleaners; but by washing about twice per week, in addition to hand cleaning, these troubles can be eliminated.

Day and Night Collection of Municipal Wastes

By William H. Edwards, Commissioner of Street Cleaning, New York City

Unpleasantness of cans of ashes and garbage standing in front of buildings is much less so at night than in the daytime. The retention of the cover on the receptacle is easier in the daytime in that animals do not prowl about and persons who find pleasure in displacing the covers do not find it convenient to do so when they are observed. Such cases as do occur where by carelessness or malice the covers are removed the day work has its disadvantage in the spreading by the wind of dust from the ashes or the generation of noxious odors by the sun's effect upon the garbage.

At best, the receptacle is some obstruction to the pedestrians and therefore is a disadvantage in the daytime and much less so at night. Interference with regular traffic by vehicles whose work causes them to stop and start frequently and at times to cross the street is also considerable.

Where receptacles are placed within an areaway there is disadvantage in night collection owing to the difficulty which the collector experiences in seeing whether there is material to remove or not.

The emptying of the receptacle into the cart or truck is necessarily attended by some noise at night. The noise of vehicular traffic, while of no great importance in the daytime, becomes of considerable importance during the sleeping hours.

The effect of the intense heat of the sun radiated from the pavements in the summer-time is a distinct drawback both to men and animals in day collection and is completely obviated in night collection. The spilling of material from the vehicles is likewise disadvantageous in day collection and is of small comparative importance in night collection, as arrangement can be made for the sweeping up of the litter before the use of the streets in the day time.

When the materials collected at night arrive at the dumping points there is a charge to be made as an economic disadvantage for the necessary lighting.

During the whole process of collection the one particular disadvantage of night work comes from the fact that supervision of the work is made considerably more difficult than where the supervising officer has the advantage of broad daylight.

I am convinced that night collection should be chosen in the case of New York.

Cost System for Street Cleaning in Washington

By J. W. Paxton, Superintendent of Street Cleaning, Washington, D. C.

Three sets of unit costs are recorded by the system of accounts maintained by the department of street cleaning in Washington, D. C. The first consists of the sum of those charges which are directly dependent on the foreman or gang, such as payrolls, and is the working total, representing those charges which admit of direct comparison. This total, added to the indirect costs, such as those of superintendence, gives a second total, of value in comparing local costs with those of other cities where these items are included. A third total is obtained by adding to the second a theoretical interest on investment, depreciation, etc., for comparison with outside contract cost. These last totals are only computed annually. The first or working unit cost is compiled monthly.

It was found that the day-labor unit costs, as compared with contract prices, were lower for all classes of work except alley cleaning. Under contract, alleys were cleaned for 40 cents per 1000 sq. yd. The figures for September, 1911, under municipal operation, gave 43.3 cents. Special study was then given to the alley gangs and various experiments, including the use of an alley machine broom, were tried, which in October reduced the cost of one gang 5½ cents per 1000 sq. yd. New schedules were arranged which, so far as practicable, eliminated dead travel, and the various foremen were carefully informed of the success of their rivals. The average for April, 1912, showed a cost of 21.8 cents, while the yearly average was 32.4 cents per 1000 sq. yd., or 7½ cents less than the contract cost.

The general opinion throughout the street-cleaning organization previous to the institution of the cost of record was that the two sprinkler five-machine combination was the cheapest, as a much larger amount of area was covered, but experiments showed that one sprinkler and three machines were the most efficient combination. The cost for April, corresponding to the 17.9 cents for September, was 15.5 cents, while the minimum April cost was 12.2 cents, the average cost for the year being 16.2 cents, or more than 6 cents less than contract.

It was found that the two-sprinkler five-machine combination was high in unit cost because of the non-productive sprinklers, and that while the machines were traveling about 25 miles per day, the sprinklers were only making 15 miles. The four-machine one-sprinkler combination, on the other hand, gave the lowest unit costs, the sprinkler charge being divided among four instead of three productive machines; but it was found that the sprinkler horses were traveling between 35 and 40 miles per day in an effort to keep ahead of the machines, the latter traveling about 25 miles. The one-three combination, on the other hand, while slightly more costly than the one-four

combination, reduced the sprinkler travel to about that of the machines.

The principal advantages of the cost-keeping system may be summarized as follows: The detailed cost for each gang, for each class of work or for any particular feature which may be under investigation is available in such form as to admit of analysis of any variation in previous costs or comparison between similar details of other work, as well as showing the result in any change of method. Means of determining the relative efficiency of foremen or laborers and a tangible record for educational purposes are provided, giving in money the effect of any internal change in the make-up of a gang and means of competitive comparison between gangs. Records of intermediate costs, such as stable, repair shop or office expenses, in which the greatest possibility of saving lies, are given in terms which admit of comparison with other departments or firms, as well as internal comparison between two units, such as two stables of the same department. Repair costs, which in time will give comparison as to the relative efficiency of two similar pieces of apparatus of different manufacture, as well as a check on excessive repairs, are recorded.

Value of Routine Water Analysis in Sanitary Surveys

By H. E. Barnard, Chemist, Indiana State Board of Health

In the last five years we have investigated the sanitary condition of the water of the southern end of Lake Michigan, of the Calumet River, the Ohio River for some 360 miles, and the Wabash River. Following the usual procedure, we have estimated nitrates, nitrites, chlorine, oxygen dissolved, oxygen consumed, hardness, odor, turbidity and sediment, and in addition we have made bacterial counts and the presumptive test for *B. coli* with frequent checks to positively identify the colon bacillus.

Streams so loaded with sewage as the Ohio, Wabash and White Rivers show a surprisingly low nitrate content which varies so slightly following the introduction of fresh supplies of sewage as to be negligible in the interpretation of results. The nitrite factor is of little moment in the analysis of river and lake waters, varying more widely during conditions of high and low water than because of the inflow of sewage or the oxidation of nitrogenous material.

Free and albuminoid ammonia contents are variables depending more upon low and high water, temperatures and normal vegetable growths than upon pollution, except in the case of waters so grossly contaminated as to be classed as dilute sewages.

We have found, however, that two factors are of prime importance: dissolved oxygen and oxygen consumed. The amount of oxygen required to oxidize the organic matter present in a water varies directly with the organic content, and is a very satisfactory indication of the condition of the river waters of the central states where algal growth is slight and where, in a large measure, organic matter is present as a result of the introduction of sewage and manufacturing wastes.

The oxygen consumed content of a strongly colored pond water is extremely high, but can not be interpreted as indicative of pollution. If, however, the factor is determined upon a river water naturally low in organic content, a high value has a positive meaning. It too is a variable, being influenced by turbidity factors and by the rise and fall of the stream.

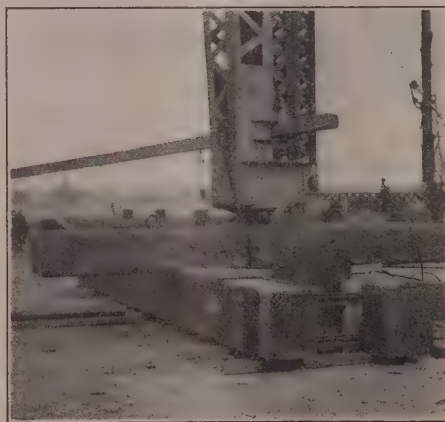
The dissolved oxygen content is equally help-

ful and is of special moment if considered in connection with fish life. This factor varies surprisingly under different conditions of flow, naturally being heavier below falls, rapids and riffles than in quiet pools.

We have reached a conclusion that the only analyses of real moment are the oxygen consumed and dissolved oxygen analyses, supplemented by a bacterial count, and the determination of the presence or absence of the colon bacillus.

Erection Derricks Supported Independently of Concrete Floors

A method of supporting derricks used for the erection of the steel framework in the ten-story reinforced-concrete Loose-Wiles Biscuit Company Building, Long Island City, N. Y., has been designed by the Turner Construction Company, contractor for the building. The reinforced-concrete beams and girders in the first seven floors are carried on steel columns erected in three-story sections by two guyed steel derricks, weighing 8 tons each, which assemble them three stories in advance of the



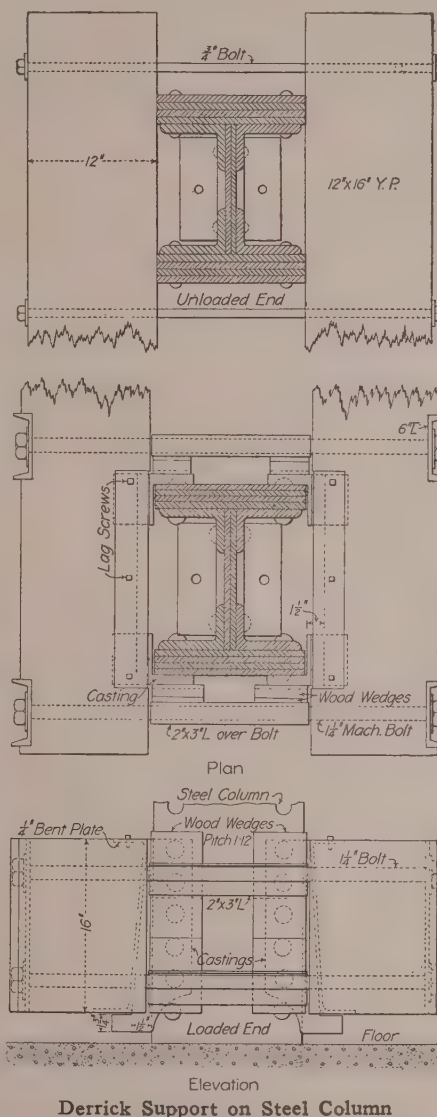
Erection Derrick Supported by Columns

concrete-floor construction. The derricks are set at any point, but generally near the steel column of the story below, thus reducing the bending moment on the new concrete floor-slab, and with their burdens they impose loads of 15 tons or more, which should neither be concentrated nor distributed on new concrete. In order to avoid this and to eliminate the use of shoring and wedging a special support for the derricks has been provided by clamping pairs of 12 x 16-in. wooden beams to the columns a few inches clear of the floor surface.

A vertical casting about 18-in. long and L shape in cross-section is fitted to each of the four corners of the I-shape column, one leg of the casting being provided with recesses to clear the rivet heads in the flange plates. The other leg is turned inward, parallel with the column web, and is wedge shape with the thick end down, and takes bearing against the correspondingly bevelled face of the 12 x 16-in. wooden beam parallel with the column work, which is faced with a 1/4-in. bent plate for its bearing on two of the castings. Two beams, on opposite sides of a pair of columns, are bolted together with two 1 1/4-in. horizontal through bolts on each side of each of the columns at opposite ends of the beams, thus clamping them securely to the columns so that any slight vertical displacement of the beams will develop a strong wedge action, holding them firmly in position without danger of slipping downward under the derrick loads.

The foot block of the derrick can be seated on the beams at any intermediate point be-

tween the columns and the supports can be unbolted and installed on another column in an hour whenever it is necessary to shift the derrick. As there are no steel beams or girders in the lower floors of the building, this device enables the derrick to be carried up



Derrick Support on Steel Column

with the columns independent of the concrete floors and without any danger of injury to the latter.

Excavation under Water

Heavy submarine excavation will be required for the Government dock at Vancouver, B. C., for which appropriations sufficient to cover the first year's construction have already been allocated. The new dock is to cost between \$1,500,000 and \$1,750,000 and is to be completed within two years. It will be 800 ft. long and 300 ft. wide, and the berthing slips on each side will be 140 ft. wide, dredged to a depth of 36 ft. at the lowest water. It will be necessary to excavate about 125,000 cu. yd. of material below low water before actual construction can start. Solid rock in excess of 100,000 cu. yd. will have to be drilled and blasted under water, it is said, in depths varying from 5 to 36 ft. When the excavation is complete twenty-three large timber cribs are to be built in drydock, sunk at the required points and then filled with broken rock. On top of these cribs a sawn-timber foundation requiring 11,000,000 ft. b. m. is to be laid and topped off with a layer of concrete. Upon this composite foundation a retaining wall is to be constructed.

Grade Revision from Paris to Winchester

Louisville & Nashville Reconstruction in Kentucky, with Details of 80-Foot Arch with Mass Ring and Reinforced End and Wing Walls

Grade revision and double-tracking now being prosecuted between Paris and Winchester on the Louisville & Nashville Railroad will supplement a previous program of such work from Cincinnati to Paris and give the coal to be brought to Winchester on the line being built from Irvine a 0.3 per cent grade northbound against traffic, with a 0.5 per cent grade in the reverse direction. The section is 16 miles long. The country, contrasted with that traversed by the Winchester-Irvine line, is gently rolling, and the old line, by the rather frequent use of curves, avoided any very heavy grading. The line as relocated eliminates much of the curvature, deviating from the old right-of-way as much as 2000 ft. in places, and cutting across the drainage, introducing a number of long cuts and fills—low as compared with those on the Winchester-Irvine line, but involving large quantities. Where the old location is followed the profile is changed radically.

EXCAVATING 45-FOOT CUT

For the first $5\frac{1}{2}$ miles from Paris, Hough & Spradlin, of Knoxville, Tenn., are doing the grading. At one end of the contract is a 45-ft. rock cut $1\frac{1}{4}$ miles long, involving 250,000 cu. yd. Two Marion 60-ton steam shovels, an Oliver spreader, four 18-ton Vulcan and two 18-ton Porter dinkeys, and side-dump cars of the 4-yd. Western and the 8-yd. Oliver types constitute the major equipment. The material from the cut is largely being wasted over a broad area adjoining the right-of-way, and few special problems have been encountered. Duane & Carland, of Toledo, Ohio, are grading the next $3\frac{1}{2}$ miles. Their contract follows the old location for the most part, and they are using standard-gage equipment, with 12-yd. 40,000-lb. Western air-dump cars, made by the Western Wheeled Scraper Company,

of Aurora, Ill. Their shovel is a Bucyrus. The remainder of the grading is being done by the Mason & Hanger Company, of Lexington, Ky.

In the northern part of Winchester the Lexington & Eastern Railway is carried over the Louisville & Nashville. The new location for the latter is 200 ft. or so west of the overhead bridge and about 15 ft. higher than the old, bringing it about 10 ft. lower than the



80-Foot Arch under Construction, with Trestle Detoured to Avoid Interference

Lexington & Eastern. The smaller road is now controlled by the larger one, and it will be cut down on sharp grades and carried across the Louisville & Nashville at grade. The latter will in turn get down to its existing grade crossing with the Chesapeake & Ohio Railway $\frac{1}{2}$ mile south.

REPLACING BRIDGES WITH EMBANKMENTS

On this section between Paris and Winchester, as elsewhere, the company's general policy is being adhered to of replacing open

bridges, of which there are but few, with solid embankments on arches or box culverts. At one point a bridge of two short girder spans with a stone center pier is being replaced with an arch, the center line of which is practically the center line of the pier, the new railroad center line being somewhat shifted, so that the single-track pier comes near the end of the arch barrel. The part of the pier falling within the cross-section of the arch ring has been chipped in as far as can be safely done without weakening the support for the girders, leaving a fresh, rough surface. The concrete arch ring is being built directly up to the pier, thus incorporating the pier in the arch. After the load has been shifted to the

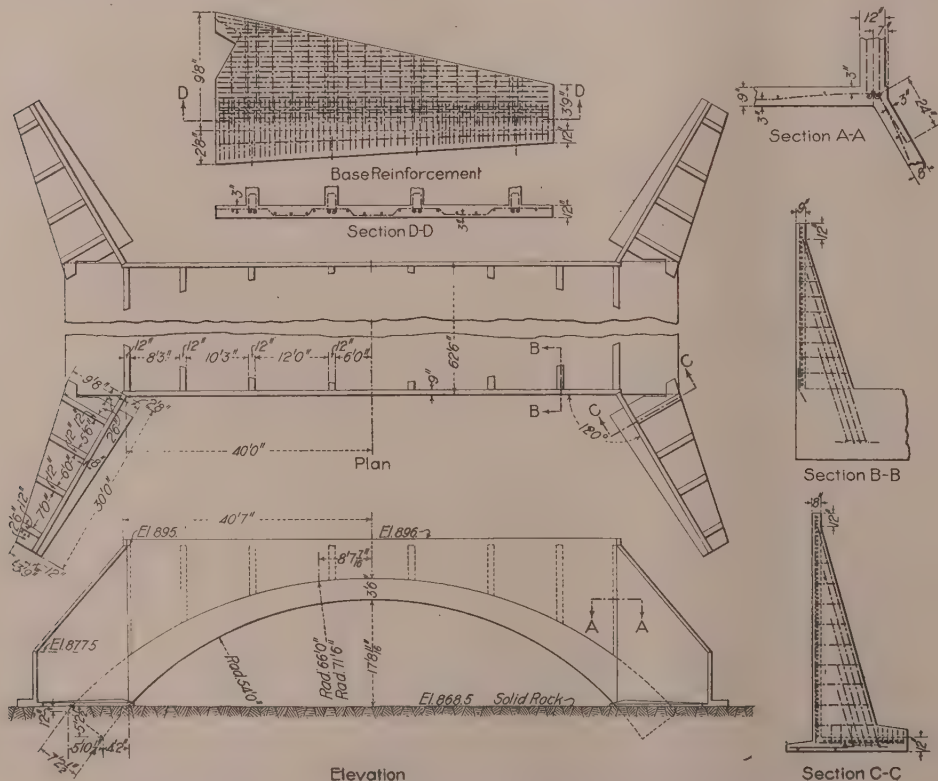
arch and the girders have been removed the portion of the pier below the arch ring will be cut down and cleared away. The small section on top will be left.

The principal concrete structure on the work is the 80-ft. arch over Johnson's Creek at Renick, details and a photograph of which are shown. It will be seen that the arch is low and comparatively short; that the ring has no footings, bearing directly on solid rock; and that only the parapet and wing walls are reinforced.

This arch is on a new right-of-way, about 600 ft. from the old. The concrete materials are unloaded from the present tracks and conveyed to the work on tramcars. The tramway carries the cars up the incline shown on the left in the illustration, whence the materials are dumped into the hopper of a United States mixer run by a Dake engine. The derrick shown handles the fresh concrete, reaching all parts of the arch. The temporary trestle used in making the fill detours around the arch, in no way interfering with it. The illustration represents conditions as they were in March. Since then the barrel has been completed and the forms for the far parapet have been placed. Mr. H. W. Miller, of North Mount Vernon, Ind., is the contractor for this structure, as well as for the remainder of the concrete work on the Mason & Hanger and the Duane & Carland grading contracts.

The work is being carried out under the general direction of Mr. John Howe Peyton, chief engineer of construction, and the more direct supervision of Mr. H. G. Laird, division engineer. Mr. W. H. Courtenay, chief engineer, has charge of the detail designing.

HEMLOCK AND TAMARACK TIES put without preservative treatment into an experimental test track near Janesville, Wis., were decayed after five and one-half years' service, as shown by a recent inspection. Similar ties that had been treated with preservatives were practically as good as when laid.



Details of 80-Foot Arch, with Mass Ring and Reinforced End and Wing Walls

Surge Tank at San Francisquito Power Station No. 1

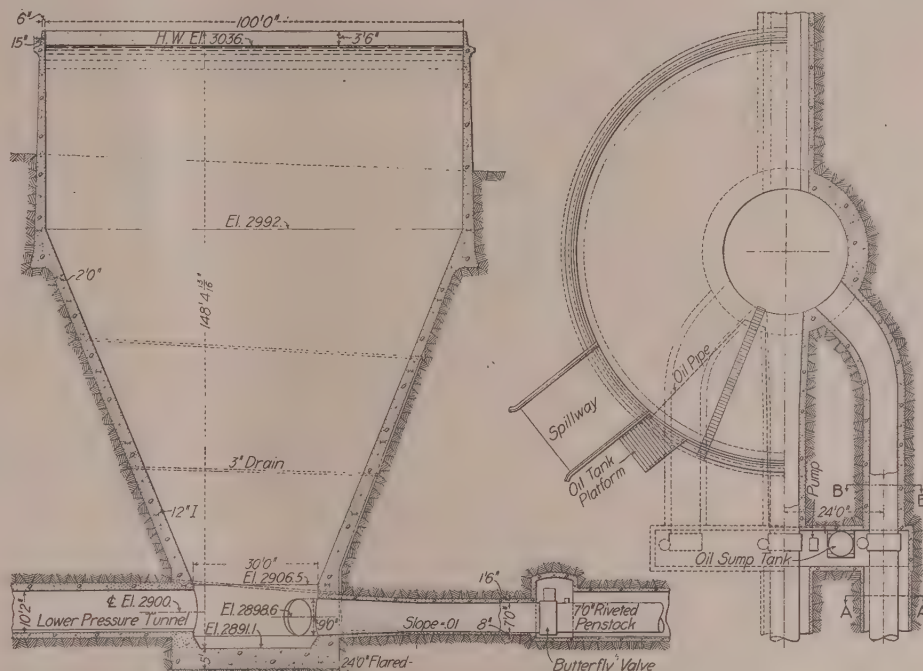
Large Concrete Standpipe Built in Connection with the First of a Series of Power Developments on the Los Angeles Aqueduct

A funnel-shaped surge tank of giant proportions, now under construction at the upper end of the steel penstocks feeding the 69,000-hp San Francisquito Power Station No. 1, on the Los Angeles aqueduct, 47 miles from the city, serves to avoid possible water hammer, pressure waves or sudden changes of head in the $7\frac{1}{2}$ miles of pressure tunnel behind it, and acts as a relief and protection for the penstocks. The San Francisquito station was described in the Engineering Record of Aug. 23, page 218. The location was selected to profit by the head of water in the Fairmont reservoir and at the same time secure a more convenient and efficient method of control through the Elizabeth Lake tunnel. The design follows closely the theory worked out by Prof. W. F. Durand, as noted in the Engineering Record of July 29, 1911, page 133. The tank is of such dimensions and form as to allow of an increased flow of 400 sec.-ft. at the power house at any time, regardless of the initial or existing flow within the ultimate 1000-sec.-ft. limit, without experiencing a fall of water level in the chamber below the hydraulic gradient corresponding to the increased flow; that is, the water level in the surge chamber will settle down gradually to this steady condition, thus avoiding any oscillation, as well as the possibility of the water level dropping down to the tunnel opening, thus admitting air. A complete shutdown at the power house can only cause a gradual rise of the water in the chamber, resulting in some spilling in extreme cases.

As an average of 400 sec.-ft. of water must pass the aqueduct ultimately, the flow past this plant and a second one to be built at some future time will vary from 0 to 1000 sec.-ft. On account of friction the net head will vary from 941 ft. static head with no flow to 814 ft. at 1000 sec.-ft. of draft. The average output will be 30,000 hp and the maximum 69,370 hp. At present three 14,000-hp units are being installed, but the surge tank is, of course, to be constructed full size.

Professor Durand's theory indicated that the

elements of the surge chamber should be a parabola, as noted in Engineering Record of Aug. 12, 1911, page 188; but for construction purposes the lines were straightened out as shown in the accompanying cross-section. While the tank is built in solid rock 411 ft. from the tunnel portal it is of concrete rein-



Surge Chamber, with Room for Operation of Butterfly Valves

forced for internal and external hydrostatic pressure, because the distance to the surface at right angles to the tunnel is only approximately 250 ft. Three steel pipes, concreted to the rock tunnels, lead from the surge chamber to emergency butterfly gates, located in a valve chamber, to which entrance is gained through any one of the concrete-lined tunnels, as the penstock pipes are set on piers on the invert.

for bursting pressure. Little or no ice will form at this elevation.

A special motor-driven bar-bending machine for the large steel bars has rollers made of cast iron. Although 50 per cent of the bars are $1\frac{1}{4}$ and $1\frac{1}{8}$ in. square, twisted, the rollers were not renewed. The sharp bends in the bars, bent to pass under the I-beam rings, were made after heating.

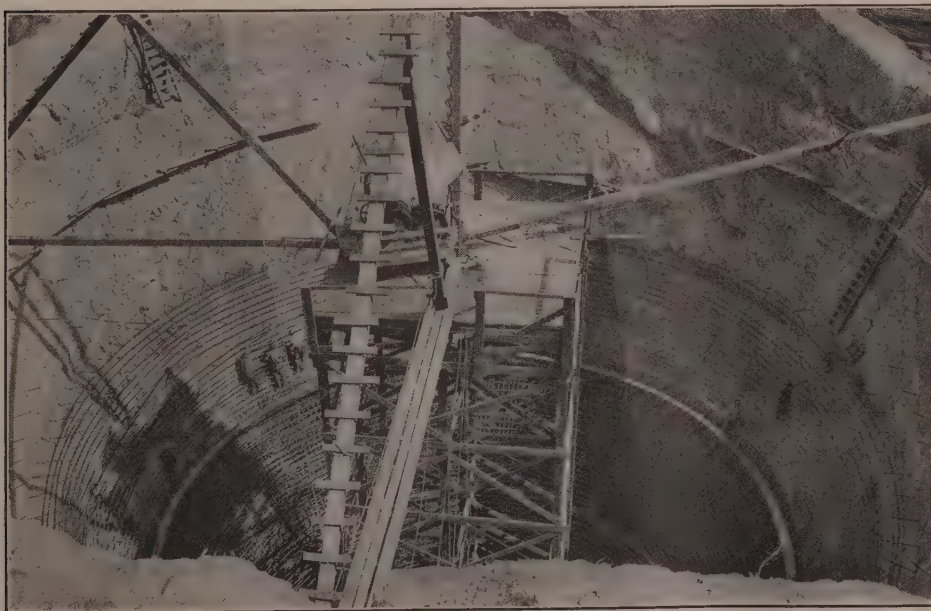
To confine the spilling to one point and lead the water to a ravine to the right of the penstocks a weir, 19 ft. 8 in. wide with its crest $2\frac{1}{2}$ ft. below the top of the chamber, has an apron of concrete on a 3.4 to 1 slope dropping to the ground. The slab is 4 in. thick and the sides are $1\frac{1}{2}$ ft. deep at the top and 2 ft. deep at the bottom.

A platform at the top of the tank alongside the spillway weir will carry an oil tank, furnishing a gravity supply to operate the butterfly gates.

CONSTRUCTION

Rock excavation of the surge chamber was started from the bottom after the tunnels had been driven. A 6 x 6-ft. shaft was driven up through the roof of the tunnel and the material, largely granite, was allowed to drop into a hopper, from which it was loaded into dump cars. As soon as the shaft was driven work was started at the surface, the spoil being thrown down the shaft.

To handle the 1,100,000 lb. of twisted steel reinforcing, concrete and forms a tower about 20 ft. square was erected in the center of chamber and an A-frame derrick mounted on the top. A distributing concrete hopper, placed

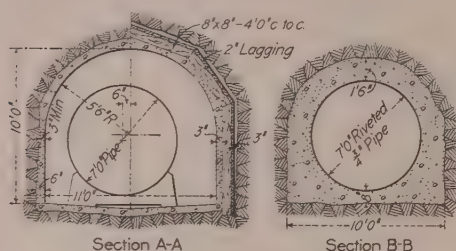


Partly Constructed Surge Chamber, Showing Method Used in Placing Reinforcement

on a platform below the derrick, supplies several secondary chutes leading to the forms, so that concrete is deposited in rings rather than in vertical sections.

Forms consist of 4 x 4-in. posts set upon the nearly vertical inclines, four of them set parallel 4 ft. apart with shorter intermediate posts in the triangular areas left between the sets of four. This method enabled the use of 4-ft. horizontal 1-in. lagging and made the horizontal cross-section a series of 4-ft. chords instead of true arcs of a circle; but the diameter is so large it was not considered essential to bend the lagging.

Set on the highest ground around the chamber, the concrete plant is reached by a trestle, over which a motor-driven hoisting engine pulls the ½-yd. dump cars of aggregate from the crusher plant at the foot of the tunnel spoil bank and the cement from the tunnel level, much of the cement having been brought through the Elizabeth tunnel by the electric



Section A-A Section B-B
Penstock Above and Below Valves

locomotives from the tufa cement-grinding plant at Fairmont. Both the cement and the aggregate were dumped automatically, the latter into hoppers high enough to feed by gravity into the motor-driven ¾-yd. Ransome mixer, from which the concrete was discharged to the hopper on the tower in the center of the surge chamber. When the wall had been built up to the ground level, too high for gravity flow from the mixer, the concrete was distributed by buggies.

Water was furnished by gravity from tanks on a hill, to which it is pumped from springs encountered in the tunnel.

Handling the tunnel spoil to the trap over the Aurora crusher is accomplished by two motor-driven hoists operating a fresno as a drag-line scraper. Three men with this rig do the work of six teams and seven men, with a corresponding daily saving of about \$12. No sand is used, but the dust and grit from the crusher run are separated by a screen so as to obtain a 1:2:4 mixture.

Construction of the power development is under the supervision of the Bureau of Los Angeles Aqueduct Power of the Board of Public Works, of which Mr. William Mulholland is supervising engineer; Mr. E. F. Scattergood, chief electrical engineer; Mr. T. A. Panter, chief assistant engineer on design, and Mr. H. C. Gardett, assistant engineer in charge of construction. All work is done by force account, with Mr. A. P. Cox in immediate charge of the surge chamber and tunnels carrying the penstocks, and Mr. O. W. Peterson in charge of the penstocks and butterfly gates. Mr. C. L. Hoon is in charge of the power plant. Prof. W. F. Durand, Mr. O. H. Ensign and Prof. Harris J. Ryan are retained as a consulting board of engineers on the power-plant development.

THE ENLARGEMENT OF THE SUEZ CANAL is expected to be completed during the coming year. The work, which has been carried on for several years, includes deepening of the canal from 26 to 33 ft. and extending its width from 98 to 148 ft.

Uniformity in Water-Supply Plans

New Jersey State Board of Health's New Regulations Governing Preparation and Submission of Designs for Water-Supply and Purification Works

In the Engineering Record of Sept. 6, page 273, there were printed the new regulations of the New Jersey State Board of Health governing the preparation and submission of designs for sewerage systems and treatment works.

The following rules and regulations have been adopted by the New Jersey Board of Health, embodying the requirements with which all applicants for the approval of designs for water-supply and water purification systems and extensions therefor should comply before the application is submitted to the board:

Submission of Plans (1).—Plans shall be submitted to the Board of Health of the State of New Jersey for examination at least two weeks prior to the date upon which action by the board is desired. From this it is not to be inferred that action by the board will always be taken within the time mentioned.

Information Required (2).—The plans for a complete water-supply and water-purification system shall consist of the following parts: A general plan of the municipality or district, showing the proposed system; detailed drawings showing construction of any special structures in the distribution system; general and detailed plans for the water-purification works; a comprehensive report upon the proposed system by the designing or consulting engineer. This report is to be typewritten upon letter-size paper, and the sheets firmly bound together. A preliminary report, containing data and information sufficient for the complete understanding of the project may be submitted to the State Board of Health for its consideration prior to the submission of detailed plans.

General Plan (3a).—The general map referred to in paragraph 2 shall be drawn to a scale not greater than 100 nor less than 300 ft. to 1 in.; and covering the entire area of the municipality or district to be supplied with water, and shall accompany each application in the case of a new water system, or any extension or modification of any water supply or water purification system, unless such a general plan of the entire area has been previously submitted.

If the municipality is greater than 2 miles in length, the map may be divided into sections, conforming in size to those mentioned in section 7 of these rules. The sheets shall be bound together and a small index map supplied, showing by number the area covered by the various sheets.

Details of Map (3b).—This map shall show all existing or proposed streets, the surface elevations of all street intersections, and the elevations of the principal parts of the water system, such as water at the intake, in the reservoir or standpipe, etc. The map should show that water-supply facilities can be provided for all sections of the municipality or district, even though the construction of pipe lines in some of the streets is to be indefinitely deferred. The location of intakes, valves, hydrants, reservoirs, pumps, standpipes and purification plant, and any special structures, shall be shown and referenced in a legend near the title. The size of pipes shall be written between the street lines and along the pipe. The map shall also show the true or magnetic meridian, title, scale, date, the municipal or district boundaries, the mean,

low and high-water elevations of water at the intake. If the site of the pumping plant is subject to flooding, the elevation of the highest known flood water must be given.

Lettering, Lines and Symbols (3c).—Letters and figures shall be clearly and distinctly made. Pipe lines to be built at present shall be shown by solid lines and those to be later constructed shown by broken lines. All topographical symbols used are to be the same as those used by the U. S. Geological Survey.

Elevations (3d).—The elevations of the street intersections shall be placed outside the street lines in the upper right-hand angle or opposite their respective positions in the street.

Detail Drawings (3e).—Detail drawings of all special appurtenances, such as blowoffs, siphons, intakes, conduits, reservoirs, collecting galleries, filters, etc., shall be submitted. (3f) Profiles of long conduits or pipe lines may be plotted to a convenient scale and shown on sheets of the sizes mentioned below.

Purification Works: General Plans (4).—The plans for the purification works shall consist of a general plan upon which reserve areas or future extensions must be shown, and also the general layout of the various units of the process, together with the piping system.

Detail Drawings.—The detail drawings shall include longitudinal and transverse sections sufficient to show the construction of each unit and part of the plant. They shall also show the distributing, drainage and cleansing systems, general arrangement of any automatic devices, sizes and depth of stone, gravel or sand used for filtering material, and such other information as is required for the intelligent understanding of the plans.

Drawings (5).—All drawings submitted shall be neatly and plainly executed and may be traced directly on tracing cloth, printed on transparent cloth or printed on any of the various papers which give distinct lines.

Size of Drawings.—The following dimensions are suggested for ordinary use, with the exception of the general map: Distance from top to bottom, 20 or 30 in.; length, 24 in., 32 in., 40 in. or 48 in. or thereabouts. By this section it is intended to prevent the use of unnecessarily long or large maps, which are difficult to file or to use.

Title.—Each drawing shall have legibly printed thereon the name of the municipality or persons for whom the drawings are made, the name of the engineer in charge, the date, the scale, and such references in the title as are necessary for the complete understanding of each drawing.

Engineer's Report (6).—A report, written by the designing or consulting engineer, shall be presented with all plans for complete systems, and shall give all data upon which the design is based or which is required for the complete understanding of the plans.

Where a purification or treatment plant is to be constructed, a measuring device shall be provided at some convenient point, and the installation of a recording device is recommended, and in particular instances may be required.

Source of Supply.—If no purification process is provided the nature and extent of the watershed, with special reference to its sanitary condition, shall be fully and explic-

itly discussed, together with proposed methods and regulations for the prevention of accidental or other pollutions.

Map of Watershed.—A small scale map of the watershed, showing the roads and the number and character of buildings, shall be included in the report. Other features which should be discussed in the report are: Storage capacity, average depth, general nature and area of the storage reservoir, liability of odors or tastes in supply, and removal of color, iron, or hardness.

Wells and Collecting Galleries.—If the water supply is to be taken from wells, describe the number, depth, size and construction of the same; method of pumping, capacity of pumps, kind of strainer used, nature of ground through which wells will be driven, and probable flow of the wells. If collecting galleries are to be used, describe their construction.

Information Concerning Purification Plant.—The following information is required respecting the purification plant: The method of purification and a description of the units of the system; the rate of operation of each of the systems; the rate of operation of each unit of the plant; if any chemicals are used, the nature and quantity of each with a description of the appliances for adding the same to the water; a description of all conditions peculiarly characteristic of the water or locality which in any manner affect the design or operation of the system; a description of all special appliances used, any special methods of maintenance or operation of the plant, and the extent of purification expected or guaranteed.

If for purposes of fire protection it is necessary to provide by-passes, by which partly treated or raw water can be turned into the mains, they shall have valves upon them of such a character that they may be properly sealed by the State Board of Health. These valves shall not be opened except in accordance with the provisions of Chapter 317, Laws of 1912.

The report should further include a description of the nature and extent of the area to which it is proposed to supply water, or which will ultimately be supplied from the system, the quantity of water to be supplied daily, and the population to be served, the portion of the system to be constructed at present and the minimum depth of pipe below the surface of the ground. A description of any provision for future units of pumping plants, filters, etc., should be given.

Unsupplied Districts.—Should there be areas in the municipality or district which, on account of topography or for other reasons cannot be supplied with water, a definite statement to this effect must be made and the probable future supply of this omitted territory should be discussed.

Specifications (7).—Specifications and an estimate of the cost for the construction of water supply and water purification systems shall accompany all plans for new or original systems. With plans for extensions of existing systems or plants, specifications may be omitted, provided that these extensions are to be constructed in accordance with specifications filed with the original plan.

Extensions of Present Systems (8).—If the plans are solely for the extension of the existing system, only such information as is necessary for the comprehension of the plans will be required. This information shall, in general, conform to the above requirements for a complete system.

General Requirements—Application for Approval (9).—The application for approval of

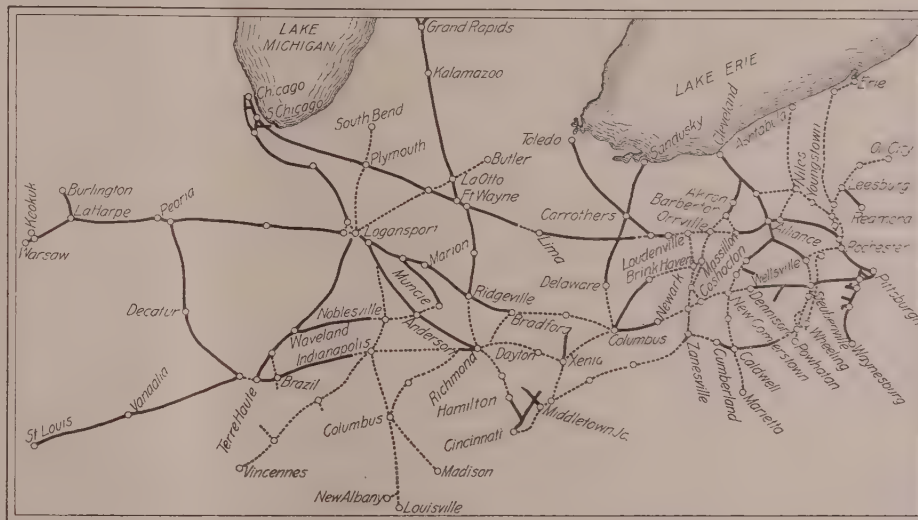
plans shall be made by the proper municipal authorities, persons for whom the work is to be done, or their properly authorized agents, upon blank forms, which will be supplied by the board.

Deviation from Approved Plans.—No deviation from approved plans shall be made unless amended plans, showing such proposed changes, have been submitted to and approved by the board.

Samples of Water to Be Analyzed.—The board will collect and analyze samples from all public water supplies at regular intervals as required by law. Requests for the analysis of special samples should be made to the board in writing, as samples will not ordinarily be examined unless collected by representatives of the board.

Pennsylvania-Lines Flood Damage

The magnitude of the damage incurred by the Pennsylvania Lines west of Pittsburgh in the March floods is graphically set forth in the accompanying map of the system, taken



Map of the Pennsylvania Lines West of Pittsburgh

Dotted portions indicate sections put out of service by the March flood

from a booklet by Mr. Lewis S. Bigelow, issued by the railroad management. The dotted lines indicate the sections that were put out of service, some of them remaining out of commission for several weeks.

It will be seen from the map that there were, roughly speaking, four large areas in which the system was put completely out of operation. First there was northwestern Pennsylvania and northeastern Ohio, and involving Youngstown, Ashtabula, Erie and Oil City. Next came the southeastern Ohio district, where the conditions were the most abnormal, although there was less population to suffer than farther west. In this section the Muskingum River expanded into a lake 50 miles long and the entire Pennsylvania system was cut in two. The next section involved all westbound connection with Columbus, and reached beyond Dayton. The fourth surrounded Indianapolis and everything south, the branch lines to Vincennes, Louisville and Madison, with their shorter individual branches, being put completely out of business.

Outside of these four major districts Wheeling was entirely cut off, as was Logansport, and there were many smaller areas of trouble. The main lines were not spared; the "Ft. Wayne" route to Chicago, the "Pan Handle" route to the same city, and the line to St. Louis were each cut in at least three places.

Canadian Steel, Iron, Coal and Coke Statistics

Steel, iron, coal and coke statistics for Canada for 1912 and for the first half of 1913 are given in a bulletin of the Bureau of Statistics of the American Iron and Steel Institute. The production of steel ingots and castings in 1912 was 853,031 gross tons, as against 790,871 tons in 1911. Of these, 645,062 tons were made by the open-hearth process and 207,569 tons by the Bessemer process, 400 tons being other kinds, in 1912, as compared with 601,074 and 189,797 tons respectively in 1911. Practically 98 per cent of this steel was produced in Nova Scotia and Ontario, the latter province leading slightly, for the first time.

The production of all kinds of finished rolled iron and steel for 1912 and for 1911 amounted respectively to 861,224 and 781,924 tons. Of the 1912 output 109,012 tons were iron and 752,212 tons were steel. Classified another way, the 1912 output comprised 423,885 tons of rails, 64,082 tons of structural

shapes and wire rods, and 373,257 tons of plates and sheets, nail plate, merchant bars, tieplate bars, etc. Only the production of structural shapes and wire rods shows a decrease. As with ingots and castings, Nova Scotia and Ontario produced the bulk of the finished rolled iron and steel—about 88 per cent of the total. Ontario produced 418,346 tons; Nova Scotia, 337,466 tons; Quebec, 88,172 tons, and other provinces the remaining 17,240 tons.

In 1912 912,878 tons of pig iron were produced, while in the first six months of 1913 545,981 tons were produced. Of the output for the first half of 1913 292,625 tons were basic pig iron, 125,052 tons were Bessemer pig iron, and 128,304 tons were foundry pig iron, ferro-silicon, ferro-phosphorus, etc. On June 30, 1913, Canada had twenty completed blast furnaces, of which thirteen were in operation. The twenty furnaces have an annual capacity of 1,391,550 gross tons, and two others under construction will have a capacity of 161,000 tons.

Coal was produced in the year 1912 to the extent of 12,957,883 gross tons, as against 10,110,168 tons in 1911, 11,526,029 tons in 1910 and 9,376,317 tons in 1909. About 15 per cent of the 1912 output was exported. The production of coke was 1,411,229 net tons, as against 935,651 tons in 1911.

Analysis of Steel Towers

Determination of Action of Wind Loads and Design of Tower Bents

By Isidore Delson, C.E., Assistant Engineer, Department of Bridges, New York City

Structural forms sometimes present perplexing problems to the designing engineer. In many cases the amount of material involved or the light loading does not make it worth while to go extensively into the analysis of the problem. But even then it is satisfying to be able to realize with some factor of certainty what, under varying conditions, is going on in the structure.

The tower shown in Fig. 1 is one of the additional supports to the end spans of the Williamsburg Bridge across the East River in the City of New York. In addition to a heavy vertical load of about 4,000,000 lb. it will have to take care of an unusually great horizontal wind reaction, estimated at about 600,000 lb. In cases of ordinary practice where such constructions are used the wind effect is usually small compared with that due to the vertical load, and would probably not receive much attention; but in the case at hand the wind reaction being great, and the height of the tower considerable, it was necessary to make a rather careful analysis of the structure.

Each of the two trusses of the bridge, shown in Fig. 1, is carried directly by a rocker post r , pin-supported by a double-webbed girder a , the latter carrying the load to the two transverse girders b . The tower can be considered as made up of two transverse bents, each consisting of two pairs of posts and a cross-girder. The arch bracing c , planned for appearance mainly, is of relatively light construction and therefore neglected in this analysis. The application of the wind load is taken on the center line of the transverse girders b , at a distance of 87 ft. from the base of the tower legs.

The problem then reduces itself to the behavior of a braced bent, illustrated in Fig. 2, under a horizontal load H ; each pair of columns is braced as shown.

The writer takes occasion here to review briefly the general subject of simple transverse bents, and will in this manner develop the practical design of the particular case presented.

Case 1.—Fig. 3a represents diagrammatically a simple bent, in which the bases C and D of the posts are anchored down sufficiently, fixed to resist bending, and the tops A and B have a hinged connection with the transverse member AB . The bent tends to distort in the manner indicated in Fig. 3b, and the member AB , since its ends are free, does not restrain the bending in the posts, and cannot itself experience bending; it serves merely as a strut to transmit a portion of the applied load H from point A to point B . If the two posts are equal in cross-section, length and resistance, each will very nearly resist half of H ; that is, the member AB transmits $H/2$ to point B . Each of the two posts is in effect a vertical cantilever beam; the maximum bending moment, at the base, is $M = (H/2)h$.

Case 2.—In the bent represented by Fig. 4a the columns are free to turn about frictionless hinges at their bases C and D ; the transverse girder AB , however, is supposed to be rigidly connected with the columns at A and B . Under a horizontal force H , applied as shown, the bent will tend to distort into the shape indicated in Fig. 4b. The bending moment in the columns will vary from 0 at the bottom hinges to a maximum at the top connections. For a symmetrical disposition of material each column may be assumed to take the bending for

$H/2$, or, in other words, the horizontal reactions at C and D will each be $H/2$.

Again, since all the members composing the bent are rigidly connected with one another, the bent will act as a whole in resisting the overturning effect of H , contrary to the bent shown in Fig. 3, where each column acts as an individual cantilever beam. This overturning moment is $H \times h$, and causes the vertical reactions $+V$ at D , and $-V$ at C , each of the value $(Hh)/b$, which is a direct tension in the post AC and a direct compression in the post BD .

It is interesting as well as helpful to observe that the bent as a whole may be looked upon

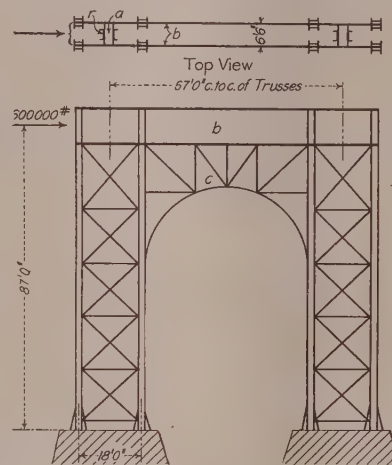


Fig. 1

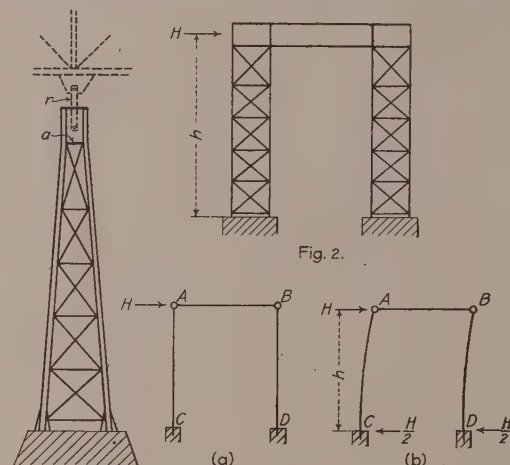


Fig. 2.

as a vertical cantilever truss or beam, in which the posts AC and BD are the chords, the latter in compression, the former in tension. Thus considered, the bendings in the posts and in the transverse girder AB are incidental or secondary, and are due to the fact that the structure is not articulated. Figs. 5 and 6 show articulated bents, no member in them being subject to bending.

As regards the transverse girder AB in Fig. 4b, in addition to transmitting $H/2$ from A to B , it is subject to bending. Fig. 7 shows the girder AB removed from the bent, and the forces and moments imposed upon it by the columns substituted for the latter. At the end A there are applied the moment $M_A = (H/2)h$ and the vertical downward force $-V = (Hh)/b$. At any point P the moment is $M_P = M_A - Vx$; at the midpoint E the moment is:

$$M_A - \frac{Vb}{2} = \frac{Hh}{2} - \frac{Hh}{2} = 0.$$

The bending moment in the girder varies from a positive maximum at A to 0 at the midpoint—i.e., the point of contraflexure—when the moment becomes negative, reaching its maximum value again at B .

The vertical axis KK of the bent in Fig. 4a can accordingly be considered as its neutral axis when the bent as a whole is viewed as a beam structure.

Case 3.—Finally, Fig. 8a shows the more usual case in which the posts are anchored down or otherwise held at their bases, and are more or less rigidly connected with the transverse beam at the top. Under the influence of the force H the bent will tend to distort in the manner indicated in Fig. 8b. The upper portion of the bent will be in a condition similar to that shown in Fig. 4. The posts suffer a

reversal of flexure on account of the fixedness of their lower ends. Somewhere between the top and the base of each post there is a point of no bending or contraflexure, M and N , which, for purposes of analysis, is equivalent to a hinge. It is convenient to conceive the structure separated at the points of contraflexure. Fig. 9 thus represents the bent above $M-N$, which is Case 2 exactly. The forces V (tension in AC , compression in BD) resisting the overturning effect of H are determined by the height h_1 and not the full height h of the bent, and are each equal to $(Hh_1)/b$. The lower portion of the posts is shown in Fig. 10. Each post is in the condition of a vertical cantilever, which in addition has a direct stress V applied to it.

The solution of the problem depends then upon knowing the position of the point of contraflexure M or N , which is frequently assumed half way between A and C . Its exact

location depends obviously upon the degree of rigidity in the connection between the transverse beam and the posts.

Professor Hiroi in his book, "The Statically Indeterminate Stresses," etc., develops by the method of least work a well-known formula for the position of the point of contraflexure:

$$h_0 = \frac{bI_1 + 3hI_2}{bI_2 + 6hI_1} h$$

in which I_1 is the moment of inertia of the girder AB and I_2 that of each post. The formula implies sufficiently rigid connections between the members and at the bases.

DESIGN OF TOWER BENT

The tower whose design is here discussed is considered as coming under Case 3. Each braced pair of posts, as AC and $A'C'$ in Fig. 11, is taken as a unit to resist the bending caused by the application of H . The strength and disposition of material being symmetrical about the center line KK , the horizontal reaction for each "unit" is $H/2$. As in the simple posts of Case 3, there is a reversal of flexure in each of these units. The position of the point of contraflexure was computed by the formula given above: I_1 = the moment of inertia of the transverse girder AB and I_2 = that of the pair of posts AC and $A'C'$ (or BD and $B'D'$).

In order to develop the analysis of the tower bent in a concrete way, numerical values will be used, thus avoiding the complexity of too many algebraic symbols. Forces will be stated in units of 1000 lb. or "kips."

For $I_1 = 358,000 \text{ in.}^4$; $I_2 = 1,845,000 \text{ in.}^4$

$$h_0 = 0.70h = 57.9 \text{ ft.}$$

$$h_1 = h - h_0 = 26.1 \text{ ft.}$$

Fig. 12 represents the portion of the tower bent above the line of contraflexure. To find

the vertical reactions corresponding to V in the simple cases discussed, it will now be recalled that the tower, as a whole, resists the force H as a vertical cantilever beam or truss of which the posts are the chords. Therefore the posts BD and B'D' will be in compression, AC and A'C' in tension, and their direct stress proportionate to their respective distances from the center line KK, the neutral axis of the structure. Then

$$V_1 = \frac{42.5}{24.5} V_2$$

and

$$Hh_1 = 2 (V_2 \times 24.5 + V_1 \times 42.5)$$

From which

$$V_1 = 138 \text{ kips; } V_2 = 79.6 \text{ kips.}$$

the compression, 217.6 kips in the post, due to the bending of the "unit" exerts upon the girder an upward force, diminished by the downward force $V_1 = 138$ kips. At A' and B the net force is downward. Beginning at A the moment is 0, increasing uniformly to a maximum at A' of

$$M_A = 79.6 \times 18 = 1432.8 \text{ foot kips.}$$

The moment then decreases to 0 at the center line KK of the girder, namely,

$$M_K = 1432.8 - (138 - 79.6) \times 24.5 \sim 0.$$

By virtue of what has been said in the preceding discussion this result ($M_K = 0$) should be expected, as the line KK is the neutral axis of the tower bent. The bending then reverses, reaching its negative maximum at B', equal in

The tower bent below the line of contraflexure MN in Fig. 14 is analytically equivalent to two independent tower units, each acting as a vertical cantilever beam under the horizontal load $H/2 = 150$ kips, applied at the line of contraflexure, combined with which the windward posts MC, M'C' resist a direct tension, and the leeward posts a compression of respectively equal values. For each of the "units" the maximum bending moment occurs at the base and is

$$M_{max} = (H/2)h_0 = 150 \times 57.9 = 8685 \text{ ft.-kips.}$$

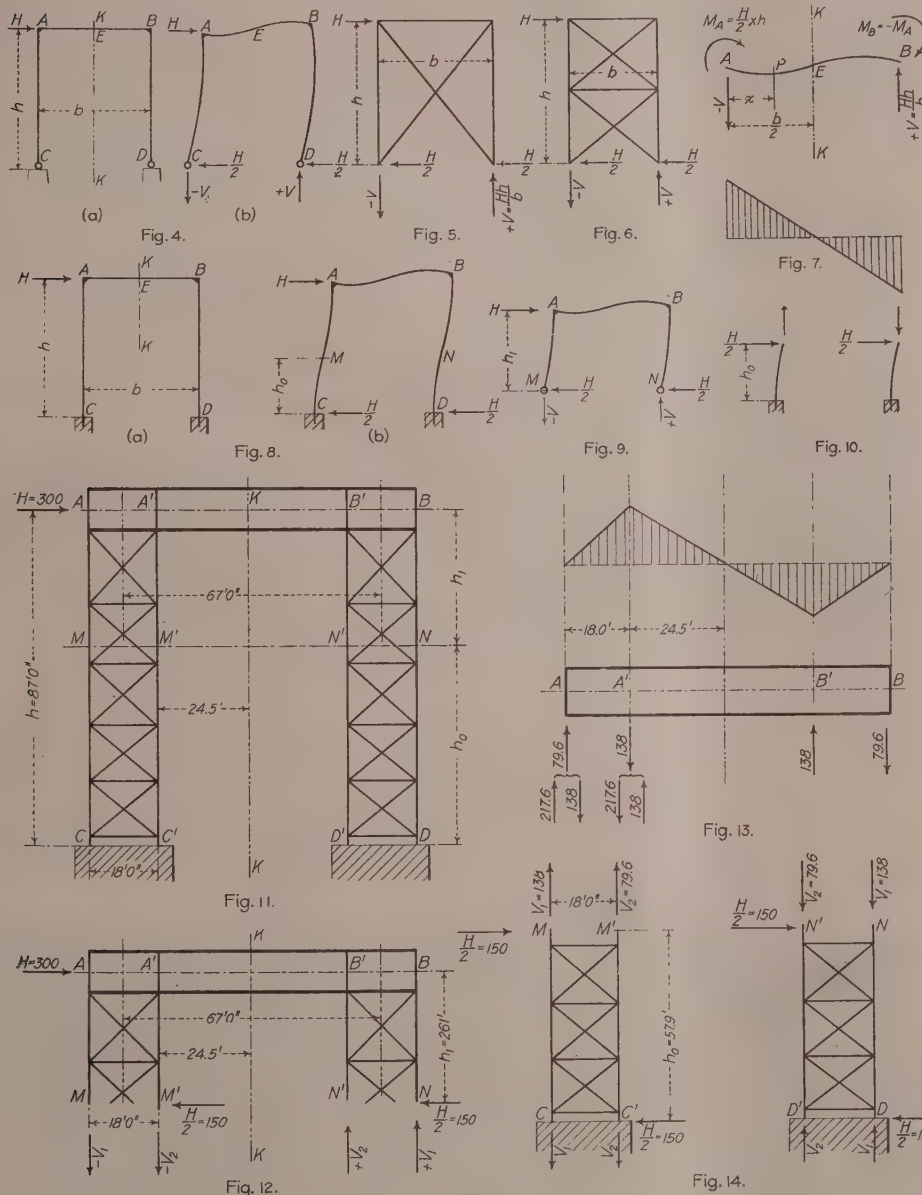
Due to this bending the stress in the posts is

$$8685/18 = \pm 483 \text{ kips.}$$

The total stress in MC is $483 + 138 = +621$ (tension) in M'C', $-483 + 80 = -403$ (compression); in N'D', $+403$; in ND, -621 .

It remains to be said that the bracing between the posts above as well as below the line of contraflexure resist a horizontal shear of $H/2 = 150$ kips.

In a practical design of this nature it is well to make allowance for possible variations from rigorous theoretical assumptions. Thus, the formula for h_0 implies a rigidity of anchorage at the base of the posts, and of connection between post and girder equivalent at least to the stiffness of the members themselves. It would be considered good practice therefore to study the effect upon the tower of a reasonable variation in the theoretically computed value of h_0 , as has actually been done in the design of this tower.



On the line AA' the bending moment in the tower "unit" will be $(H/2)h_1$, and will induce in the posts a compression at A and tension at A', whose value is

$$150 \times 26.1/18 = 217.6 \text{ kips.}$$

Similarly there is a tension in the post at B and compression at B' of the same amount.

The actual stress in each post will be the algebraic sum of V_1 or V_2 , and of this bending stress.

The transverse girder in the first place distributes H as a strut equally over the posts. Mainly, however, it must, as a girder (Fig. 13), resist the forces applied to it through the posts at A, A', B' and B. Thus at A and B'

value to that of A and decreasing to 0 again at B.

As designed, the girder is continuous from end to end, being rigidly connected to the posts. The continuity of the girder proved to be of advantage also with respect to the bending stresses resulting from the direct-truss loads, which, as already pointed out, are applied to the girder midway between A and A', and B and B'. It is to be noted also that whereas the bending moments due to wind are greatest at A' and B' those due to the direct loads are greatest at their points of application—i.e., the two maxima do not occur at the same point.

Surface-Oiled Roads in the Philippines

The use of a surface treatment of oil on the macadam roads of the Philippines is reported in the "Quarterly Bulletin" of the Bureau of Public Works as proving satisfactory even under comparatively heavy automobile traffic where proper attention has been given to the methods of application of the oil. Experiments have been conducted on small areas for some time and a study of the results of previous practice has led to several changes. Oil was applied to about $4\frac{1}{2}$ miles of the Manila-South Road last January. Preparatory to the surface treatment of oil the road was broomed, but only the finer portion of the material was removed. No water was applied, as was done before, and the oil, spread in quantities approximately $\frac{1}{2}$ gal. per square yard, was allowed to stand from thirty to seventy-two hours, until the surface was dry, before being covered with dredge-run gravel. Previous practice had been to cover it with sand from three to five hours after the oil application, and in this way much of the binder was absorbed by the sand covering and thorough penetration of the road base was prevented.

It has not been found necessary to use road rollers after the gravel has been spread, as the local traffic seems to consolidate thoroughly the binder and the surfacing. Previously the asphalt-like surface was oftentimes too thin to stand the traffic and would break through after a few months of use. Now there is no dust raised by the fastest moving automobile.

ASSIGNMENTS OF LAND FOR OIL STORAGE are now obtainable from the Isthmian Canal Commission at the ends of the Panama Canal, according to the "Canal Record." The commission proposes to install an oil-pumping plant at each waterfront and run oil mains from there to the vicinity of the oil tanks.

Brick Storm Sewer at Cedar Rapids

Construction Involved Use of Mounted Arch Center and Drag-Line Excavator

In constructing a brick storm sewer through sandy soil in Cedar Rapids, Ia., a mounted arch center and a drag-line excavator adapted to the conditions were used by the contractor to expedite the work. The sewer is on Twenty-first Avenue, West, on which it extends from C Street to Eighteenth Avenue, West, thence on Eighteenth and Seventeenth Avenues, West, to J Street. The 400-acre territory served is a comparatively low area of ancient river bottom filled in with sand, silt and loam with a preponderance of sand. At the lower end the sewer discharges into a 7-ft. three-ring brick sewer emptying at the foot of Twenty-first Avenue, West, into the Cedar River. Cedar Rapids has a complete double system of sewers, and about 20 ft. to one side of the greater portion of the new work is an 18-in. sanitary sewer. This was too far away to cause any difficulty, particularly as there were few connections crossing the line of the new work to be cared for.

At the upper end the grade is 0.25 per cent, but for the last 1000 ft. it is increased to 1 per cent. There are 1580 ft. of 6-ft. and 1260 ft. of 5-ft. sewer, which are calculated to care for a maximum rainfall of 3 in. per hour kept up for forty minutes. This assumes a runoff of 60 per cent.

About 200 ft. from the lower end the cut for 800 ft. averages about 20 ft., and sheeting was necessary. Here the trench was made 9 ft. wide inside of the sheeting, which consisted of 2 x 10-in. planks 10 and 12 ft. long, driven back of 3 x 12-in. stringers held apart by 4 x 6-in. wooden screw braces 8 ft. apart horizontally and in rows of from two to four vertically. Much of this excavation was done by hand.

MACHINERY EXCAVATION

Practically all of the excavation for the remainder of the trench was done with a Browning No. 6 locomotive hoist with a 36-ft. boom, operating a $\frac{3}{4}$ -yd. drag-line bucket from a position on the center line of the trench but ahead of the work.

To simplify the operation of the bucket and adapt it to the conditions, changes were made by the contractor as follows: The front was

cut off, reducing the capacity from $1\frac{1}{8}$ to $\frac{3}{4}$ yd. Three teeth 5 in. wide were riveted to the bottom and one to each side. The angle of the pulling bale was changed slightly. The tripping line was done away with by placing on the top two 8-in. channels separated at



Improved Drag-Line Bucket

each end by a 6 x 8-in. oak filler block, back of which a 10-in. sheave was fitted. On the $\frac{5}{8}$ -in. lifting line, rove through the two sheaves on the beam, a bump block consisting of a 3-in. pipe leaded to the line served to dump the bucket at the end of its travel; otherwise it hung at such an angle as to hold its load, but could be varied slightly to dig or pull out of

the trench, depending on the relative pull on the two lines. A slotted plate was bolted to the top of the channel just above the sheave for the bump block to strike against.

Most of the trench was excavated 10 ft. deep and approximately 14 ft. wide, all of the materials being piled on one side of the trench, thus leaving the other side for construction materials. Two men shaped the bottom of the trench to line and grade, throwing the material ahead to the drag-line bucket. Unless heavy rains occurred after the trench was opened the sides stood up at 1 to 1 slopes, or even steeper. In vacant property through which streets have not yet been cut the contractor's operations covered about 70 ft. in width along the trench, the earth being piled up for a 23-ft. strip on one side.

On account of the sandy nature of the material construction followed the trenching closely, usually within 100 ft. If this had not been the case the locomotive crane would have been sent back to backfill the trench. However, this latter work was done at a reasonable figure by using a team on a "go-devil," merely a flat board scraper to which was attached 75 ft. of wire rope.

BUILDING THE SEWER

Purinton vitrified paving blocks, No. 2 stock, were laid up in cement mortar, leaving $\frac{1}{4}$ -in. line joints in the inner ring and $\frac{1}{2}$ -in. joints in the outer ring. The invert and sides for $1\frac{1}{2}$ ft. high were surfaced with cement mortar rubbed until no projections exceeding $\frac{1}{8}$ in. were left. A 1:2 mortar was plastered over the upper half of the outer ring to prevent infiltration of ground water.

River sand, about the grade of torpedo sand, was screened on the job just before the mortar was mixed. As shown in one of the photographs, a mortar board was laid across the invert half of the sewer and the mixed material chuted to it from the bank.

The invert was laid to line and grade obtained by lines from a template set up over a grade stake in the bottom of the trench.

The single center, 14 ft. long, for the arch comprised seven ribs covered with 2 x 4-in. lagging. The diameter across the horizontal center line was made 1 in. less than the finished sewer diameter, and the lagging did not extend downward at the side to within 3 in. of the center, thus giving ample chance to drop the form when ready to move ahead, a mini-



Relative Positions for Invert Construction



Mounted Center Used for the Crown of Brick Sewer at Cedar Rapids

mum period of one hour always elapsing before removing.

Framed to the cross-piece of the second rib were two vertical 2 x 10-in. planks, in the lower end of which a wheel from a wheelbarrow was fitted. There were two wheels in front and one in the rear. They rested on blocking over a track of 2 x 10-in. planks supported by 4 x 6-in. cross-ties chamfered to fit the sewer invert.

In moving, wedge blocks under the three wheels were removed and the form rolled forward. Near the end of the completed arch a wedge block with a long taper was placed on the track for the single rear wheel to ascend until the form was tight against the existing crown. The front wheels were then blocked up to bring the top of the form to line and grade.

Twenty-five men and three teams averaged 35 to 40 ft. of completed sewer. They were apportioned as follows: Four bricklayers and eight helpers, including one foreman mason, two trench trimmers, two on locomotive hoist, one moving track, two backfilling with one team, one man unloading brick, one in car, one man and team hauling brick, one man and team hauling sand, coal and general teaming, one night watchman and a water boy. The contractor received \$8.95 and \$7.25 per lineal foot for the 6 and 5-ft. sewers respectively. Nine manholes cost the city \$21 each.

The work was carried out under the direction of Mr. T. F. McCauley, city engineer, by Mr. R. C. De La Hunt, the contractor.

Flood-Predicting System for the Miami Valley

The Washington officials of the Weather Bureau have granted the request of the local forecaster at Dayton, Ohio, for a number of new rainfall and river-gaging stations in the Miami River drainage basin. With the inauguration of the new stations Dayton will be assured the earliest possible warning of a sudden rise or a flood stage in the Miami River.

Heretofore all reports from the Miami basin have reached Dayton through the Columbus office of the Weather Bureau. To give Dayton the best and quickest service possible all observers will, after the commencement of the new up-river stations, report direct to the local forecaster. The Morgan Engineering Company, in connection with its efforts to provide temporary protection for Dayton until the flood-prevention work can be completed, has investigated the service rendered by flood-warning systems that have long been in use in the older countries of Europe. There is a regularly constituted branch of the French administrative service for the systematic foretelling of high water and floods at Paris and other points along the Seine. In 1883 a similar service was begun in Germany on the Rhine. Austria now has a system in operation on the Danube. Italy and Switzerland have efficient flood-warning services. A similar plan was inaugurated a few years ago on the Brisbane River in Queensland, Australia.

The U. S. Weather Bureau now maintains a river-gaging and rainfall service for the prediction of flood stages on all the larger and some of the smaller rivers in this country. Floods on the lower Mississippi River are predicted with great accuracy, and sometimes four weeks in advance, merely by comprehensive knowledge of conditions of rainfall and runoff at its headwaters. It is estimated that hundreds of millions of dollars in damages have been avoided by this service.

Concrete Specifications for Bridge Substructure

Typical specifications for the fabrication and erection of steel highway bridges were issued recently by the U. S. Office of Public Roads. The requirements for steel superstructures were published in the Engineering Record of Aug. 30, page 230. An abstract of the specifications for concrete masonry is here presented, omitting only a few universal requirements and obvious or unimportant clauses.

Cement.—The cement shall be of some standard brand of Portland cement satisfactory to the engineer in charge. No cement shall be used which, when tested, fails to conform to the United States Government specifications for Portland cement as contained in Circular 33 of the Bureau of Standards.

Sand.—The sand shall consist of dry, clean quartz grains and shall not contain more than 5 per cent of clay, loam, or other foreign materials. The grains shall be well graded and of such size that all will pass a $\frac{1}{4}$ -in. mesh screen and not more than 20 per cent will pass a No. 50 sieve.

Coarse Aggregate.—The coarse aggregate may consist of either broken stone or gravel.

Classes A, B and C.—Unless otherwise especially provided, there shall be three classes of concrete, known as Class A, Class B, and Class C.

Class A concrete shall consist by volume of 1 part of cement, 2 parts of sand, 4 parts of coarse aggregate, and water. All of the coarse aggregate shall be retained on a $\frac{1}{4}$ -in. mesh screen and shall pass a 1-in. mesh screen. Not more than 75 per cent shall be retained on a $\frac{1}{2}$ -in. mesh screen, and not more than 75 per cent shall pass such a screen.

Class B concrete shall consist by volume of 1 part of cement, $2\frac{1}{2}$ parts of sand, 5 parts of coarse aggregate, and water. All of the coarse aggregate shall be retained on a $\frac{1}{4}$ -in. mesh screen and shall pass a $1\frac{1}{2}$ -in. mesh screen. Not more than 75 per cent shall be retained on a $\frac{3}{4}$ -in. mesh screen, and not more than 75 per cent shall pass such a screen.

Class C concrete shall consist by volume of 1 part of cement, 3 parts of sand, 6 parts of coarse aggregate, and water. All of the coarse aggregate shall be retained on a $\frac{1}{4}$ -in. mesh screen and shall pass a $2\frac{1}{2}$ -in. mesh screen. Not more than 75 per cent shall be retained on a $1\frac{1}{4}$ -in. mesh screen, and not more than 75 per cent shall pass such a screen.

Mixing.—The cement and sand shall first be thoroughly mixed dry, in the proportions specified, on a proper mixing platform. Sufficiently clean water shall then be admixed to produce a pasty mortar. To the mortar thus prepared shall be added the proper proportion of coarse aggregate, previously drenched with water, and the whole shall be mixed until every particle of the coarse aggregate is thoroughly coated with the mortar. Instead of the above-described method a mechanical mixer satisfactory to the engineer may be employed.

Size of Batch.—Concrete shall be mixed in batches of such size that the entire batch may be placed in forms by the force employed within forty-five minutes from the time that the first water is applied. No concrete is to be prepared from mortar which has taken an initial set and would require retempering.

Placing.—All concrete shall be carefully deposited in place and never allowed to fall from a height greater than 5 ft. Concrete shall never be deposited in running water, nor in still water, except under direction of an engineer skilled and experienced in that special work.

As fast as concrete is put into place it shall be thoroughly tamped in layers not more than 6 in. thick, and the portion next to the forms shall be troweled by using a spade, or by other means, to bring the mortar into thorough contact with the forms.

Concrete shall not be deposited when the temperature of any of the materials composing it is below 35 deg. Fahr., and if during the progress of the work freezing temperature threatens or is predicted by the United States Weather Bureau, proper precautions shall be taken to protect from freezing all concrete laid within the four preceding days.

Forms.—Forms shall be so constructed as to continue rigidly in place during and after depositing and tamping the concrete. If during the placing of the concrete the forms show signs of bulging or sagging at any point, that portion of the concrete causing the distortion shall be immediately removed and the forms properly supported before continuing the work.

All forms shall be left in place not less than thirty-six hours and all supporting forms not less than ten days after the concrete has been deposited. These periods may be increased at the discretion of the engineer in charge.

Joints.—When the work of laying concrete is to be interrupted for a period greater than one hour and there are no reinforcing rods projecting, provision for a joint shall be made in the following manner: Square 8 x 8-in. timbers, or some other suitable size approved by the engineer, shall be bedded in the concrete throughout the length of the course for one-half their thickness and allowed to remain until the concrete has taken its initial set. When the work of laying concrete is resumed, the timbers shall be removed and the surface thoroughly wet. No joints will be permitted in reinforced-concrete beams, and in floorslabs the joints shall be vertical and parallel to the main reinforcing bars.

Finish.—Forms covering surfaces of the concrete masonry which are to be exposed shall be removed immediately after the expiration of the period of time necessary for such forms to remain in place, as fixed by the engineer, and all crevices which may appear shall be filled with 1:2 cement mortar. These surfaces shall then be finished with 1:2 cement mortar and a wooden float, so as to present a smooth, neat appearance.

Reinforced Concrete.—All reinforced arches, beams, floors, parapets, guard rails, and all concrete masonry measuring less than 9 in. in thickness shall be made of Class A concrete, unless otherwise specified on the drawings or directed by the engineer in writing.

Abutments and Wing Walls.—Unless otherwise specified on the drawings or in writing by the engineer, Class B concrete shall be used for all abutments and wing walls the thickness of which is not less than 9 in.

Footings and Cutoff Walls.—Class C concrete shall be used for all footings and cutoff walls, unless otherwise specified on the plans or directed in writing by the engineer.

Steel for Reinforced Concrete.—Unless otherwise specified on the drawings, all reinforcing steel shall consist of bars which have been deformed in some approved manner. No plain bars will be permitted except as shown on the drawings or directed in writing by the engineer.

Unless otherwise specified on the drawings or in writing by the engineer, all reinforcing bars shall be of medium steel having an elastic limit of not less than 35,000 lb. per square inch, and shall be sufficiently malleable to withstand bending cold with a radius equal to twice the diameter or thickness of the bar through 180 deg. without fracture.

Splicing Reinforcing Bars.—Unless otherwise specified on the drawings or in writing by the engineer, necessary splices in reinforcing bars shall be effected by overlapping the ends of the bars a distance equal to forty times their thickness or diameter.

Copies of the specifications are procurable from the superintendent of documents of the Government Printing Office, Washington, D. C., at 5 cents per copy.

Book Reviews

An index to the annual reports of the tests of metals made at the Watertown Arsenal has been issued recently under the direction of the chief of ordnance, United States Army. It classifies by subjects all tests published from the years 1881 to 1912 inclusive, giving the volume, year and page of its publication. (Washington, D. C., Ordnance Department.)

The American Society for Testing Materials has issued an index to the first twelve volumes of its "Proceedings," from 1898 to 1912. The book is divided into subject and author indexes, the former being prefaced by a list of key words for the ready location of subjects. (Philadelphia, American Society for Testing Materials.)

"Theory and Test of an Overshot Water-wheel" is the title of Bulletin 529 issued by the University of Wisconsin, written by Carl Robert Weidner, C.E., instructor in hydraulic engineering at the university. The object of the bulletin is to direct attention to that efficient type of motor, and to present the theory and results of some experiments performed at the hydraulic laboratory of the university. The subject, although of minor importance to the practising engineer on account of the limited application of the overshot wheel, may be of interest to those who have occasion to develop small powers, and perhaps to others from a scientific standpoint. (Madison, Wis., University of Wisconsin. 40 cents.)

Because of the part engineers have played in exterminating yellow fever, many may be interested in a pamphlet published by the Department of Agriculture from the pen of Dr. L. O. Howard, chief of the Bureau of Entomology, on the subject of the yellow fever mosquito. The bulletin gives a number of facts about the habits of the mosquito, how to recognize the fever-producing species, and their breeding conditions, all of which would be useful knowledge for engineers engaged in tropical countries. (Washington, D. C., Department of Agriculture.)

"FACTORY LIGHTING." By Clarence E. Clewell. Cloth, 6 x 9; 161 pages; 100 illustrations; 13 tables. New York, McGraw-Hill Book Company. \$2 net.

Mr. Clewell's book is a compact treatise on artificial illumination, based almost entirely on existing installations in some of the modern factories. The book does not, however, describe typical lighting systems, leaving the reader to form his own conclusions. The various factories which have served as objects of study to secure the material for this book are completely hidden as regards identity, but the conditions that were factors in the design have been analyzed and explained to enable the reader to apply them to meet his own conditions. In connection with practical results the theory of illumination is thoroughly discussed.

Office, drafting-room and power-house lighting is considered a part of factory lighting and is treated accordingly. The book is also a good

index of the latest developments in lamps and their accessories. The author was for a number of years engaged in the design and supervision of the installation of lighting systems for several large factories and is now a member of the faculty of the Sheffield Scientific School of Yale University.

The American Society of Civil Engineers has brought up to date the "Bibliography on Valuation of Public Utilities," which was prepared in May, 1912, for the use of the special committee on valuation of public utilities. The bibliography has been published in the "Proceedings" of the society for August, 1913, in the hope that it will be useful to members of the society. In the present juncture, when so much attention is being given to valuation matters, this bibliography of 61 pages should be of considerable value to engineers. It is subdivided as follows: General, electric light and power, gasworks, mining, railroads, steam power, street and interurban railways, telegraph and telephone, waterpower and waterworks.

STEAM-POWER-PLANT ENGINEERING. By G. F. Gebhardt, Professor of Mechanical Engineering, Armour Institute of Technology, Chicago. Cloth, 6 x 9 1/4; 989 pages, 605 figures. New York, John Wiley & Sons, Inc. \$4 net.

Since the first edition of this book was published 165 pages have been added and considerable of the original matter has been changed. Some of the more notable changes are the addition of sections on surface combustion, Clayton's work on the steam engine and the locomobile. The chapter on fuels and combustion has been rewritten and enlarged and more attention is given to oil burning. Other chapters have been amplified and enlarged, especially the chapter on finance and economics, where several new charts and tables have been added. The appearance in 1913 of the fourth edition of a book that first appeared in 1908 indicates the energy of the author in keeping it up to date. It is by far the best book on the subject that we have, both for class and reference, and it should be in the library of not only engineers and students but also of owners of power plants.

A TREATISE ON WOODEN TRESTLE BRIDGES. By Wolcott C. Foster. Cloth, 9 x 12; 440 pages; 76 plates. New York, John Wiley & Sons. \$5 net.
(Reviewed by Frank H. Constant, Professor of Structural Engineering, University of Minnesota.)

This is the fourth revised and enlarged edition of a work that has for twelve years been the standard treatise on wooden trestle bridges. This revision has been made with the same care and single-minded purpose of bringing the work down to the present time that has characterized the former ones. Much of the book has been rewritten and new matter has been added to every chapter. The author has made use of the work of the permanent committees on wooden bridges and trestles of the railway clubs and engineering associations, their proceedings have been drawn upon freely, and the standards and rules of practice adopted by the different associations have been incorporated in their proper places. As heretofore, all important text references are given in the page footnotes.

In justifying the present revision the author states that while it might seem at first thought that the wooden trestle bridge is losing its importance in railway work (since it is gradually disappearing on the main lines), its increased growth on branch lines, electric railways, and feeders to manufacturing plants has more than kept pace with its abandonment on main lines. Moreover, the increased use of timber preservatives, and especially the advent of concrete trestles on the main lines, has

placed trestle building upon a more permanent footing. To meet these new conditions two new chapters—one giving a short outline of timber preservation and one on concrete trestles—have been added to Part I, which now contains 236 pages and seventeen chapters.

The plates in Part II have been nearly doubled in number and include many examples of the latest practice, especially for heavy traffic. This part contains 156 pages, divided into five sections.

A new feature of this edition is the very extensive bibliography of the subject and of related matters in trestle building and maintenance. This is classified under the caption of Part III and includes about 33 pages. It covers concrete piles, piles (general and miscellaneous), pile destruction, protection and preservation, pile drivers, driving and cutting, pile formulae, tests and bearing power, pile removing and pulling, timber properties, life, seasoning, cutting, kinds, specifications, preservation, destruction, decay, timber tests and strength, and trestles (general, miscellaneous and individual). While not exhaustive, the author believes the bibliography to be very complete in the field of engineering periodicals and transactions of societies and clubs, but it does not include books. This new feature of the book will prove exceedingly valuable, enabling the reader to pursue special phases of the subject more exhaustively.

The publishers have retained the rather bulky size of the volume, 9 x 12 in., but the typographical work is, as heretofore, excellent and inviting.

This book, in its revised form, will continue to hold its own as the standard work in its field and should find a place in every engineer's library.

TRADE WASTE WATERS, THEIR NATURE AND DISPOSAL. By H. Maclean Wilson, M.A., B.Sc., and H. T. Calvert, M.Sc., Ph.D., F. I. C. Cloth, 6 1/4 x 9 1/4; 340 pages; 74 illustrations. Philadelphia, J. B. Lippincott Company; London, Charles Griffin & Company, Ltd. \$5.

The authors of this text book are respectively chief inspector and chief chemical assistant of the West Riding of Yorkshire Rivers Board, and the book itself is a collection in concise form of material which they have gathered during many years' experience, and is written with reference to the needs of not only the makers of wastes but of municipal and other authorities and their officials.

Chapter I is a short and well-written history of the use of rivers as sewers and the legal and governmental aspects of river cleaning. Then follow nine chapters describing the wastes of the coal trade, gas manufacture, grain washing, malting, brewing, distilling, the leather, paper and textile trades and miscellaneous trades, such as metalworking, soapmaking, the animal industries, mining, etc. Each chapter is well illustrated, both by figures and numerous analyses, and at the end of each chapter is a bibliography, which does not omit the literature from foreign sources.

In the chapters devoted to special trades the authors have not confined their attention to the bare waste-disposal features of the processes involved, but have in addition written a very good elementary description of the processes themselves. The book contains many typical results of analyses; these are intelligently expressed and make the book more valuable to non-British readers.

One chapter is devoted to pumps, screens, meters, tanks, filters, presses, evaporators, incinerators and other devices used. This chapter is descriptive, but does not enter deeply into the essential features of the design of some important parts of a waste-disposal plant. The British methods of controlling the dis-

charge of trade-waste waters into public sewers are described, with the citation of many laws and regulations; also, the legal status of the manufacturer who uses the sewers to carry his refuse is defined. A brief description of chemical and bacteriological analytical methods, a description of the subject of limits of impurity, and a good index conclude the book.

Most of the data seems authentic, and while the reviewer hoped to find a rather fuller discussion of the disposal of the wastes of certain industries which are more prominent outside than inside the West Riding district, the book shows the careful, first-hand work of the authors. Especially good are the chapters on paper and textile trade wastes. The treatise is more devoted to the methods of treating waste waters than to the design of the apparatus, and some engineering details, whose importance often makes or spoils the success of the processes, are not as fully discussed as a designer or operator of waste-disposal plants could wish.

Many recently discovered methods and processes are described and the illustrations are clear and comprehensible, although lacking a little in detail.

For students of waste-disposal processes, officials and others who have to do with river cleaning and sewage-disposal problems the book can be highly recommended. It is written clearly and what it lacks in detail is made up by its breadth of view and its continual suggestiveness, which make it valuable to the experienced designing engineer or operator.

CONCRETE ROADS AND PAVEMENTS. By E. S. Hanson, Editor of the "Cement Era." Cloth, $4\frac{3}{4} \times 7\frac{1}{2}$; 227 pages; illustrated. Chicago, The Cement Era Publishing Company. \$1.

Mr. Hanson's book brings under one cover a great deal of material that has been published in technical journals on the subject of concrete roads. It evidently makes no pretense at original thought or study along this line but quotes copiously from addresses given by city, county and State engineers before technical societies. It devotes considerable space to unit costs and gives in a series of appendices a number of specifications for concrete, granitoid and patented pavements.

Letters to the Editor

Engineer's Change of Location and Its Effect

Dear Sir: Your editorial note of the issue of Aug. 9 headed "Latin and Greek for the Engineer" is strikingly personal, for indeed from every quarter we hear the criticism of the backwardness of the engineer in civic and public affairs. But I believe that neither the classic nor the practical education is the most important factor in this truly grievous fault of the engineer. True, we see the doctors appointed road overseers and the lawyers put on the board of the county commissioners, while the engineer says nothing but remains a qualified voter of the same county. Is this not due in most cases to the constant possibility of the change in location of our fellow-craftsmen?

The question comes up, "If I come out openly for such and such system, am I going to be located at this place long enough to defend my position on that subject and make my influence felt, or is it that I am needed to direct a work of more importance in an adjoining county or State and by the powers that be am required to change location, if not permanently, at least long enough to lose in-

terest in the project or till the crisis shall have passed?"

Do you not think that these conditions will hit a remarkably great number of engineers?

J. B. HOLT,

Junior U. S. Engineer, Inland Waterway.
Maple, N. C.

Fire Damage to New Harriman Bridge

Dear Sir: I wish to make a correction to my recent letter regarding the fire damage to the new Harriman bridge, on page 224 of your issue of Aug. 23. The opening in the floor mentioned was probably made by the firemen. The local damage to the tower leg was caused by the burning of a gateman's house, regarding which I was not informed at the time of my first visit to the bridge.

Portland, Ore. JOHN W. CUNNINGHAM.

Forfeiture of Certified Check

Dear Sir: Will you please advise us if you know of any case where a contractor on public work forfeited his certified check, abandoned the contract, subsequently bid upon other public work to the same public body and had his bid rejected because of his having abandoned or refused to sign the previous contract. If you have any such information, kindly give the legal reason for the second bid being rejected.

EDWARD L. BADER,

By M. B. Markland, Manager.

Atlantic City, N. J.

[Possibly some of the readers of the Engineering Record can cite a case in point.—EDITOR.]

A Mexican Labor Experience

Dear Sir: Several years ago I was employed as city engineer to supervise the installation of a waterworks system in a small Southwestern town in the United States. Frost seldom visited the section and it was never cold enough to freeze water in pipes, so in out-of-the-way places we were permitted to run the pipe line along the surface of the ground, simply blocking the pipes up wherever necessary to maintain alignment and proper bearing.

We had the pipes strung along the top of the ground approximately in place, as is usually done where pipe lines are laid to facilitate the work. We employed Mexicans to do the heavy work, and I had taught a gang of them how to shift the pipes into place and lead the joints properly. I was congratulating myself on the high class of skilled labor I had succeeded in developing out of such rough material.

One afternoon I was suddenly called to the pumping plant about three-quarters of a mile away, which was then under construction, and, in my confidence, I told the pipe gang to "go right ahead." The spokesman, glad to see me go no doubt, smiled a "Si Señor" at me as I left.

I had been at the plant site for about an hour helping the erectors with the steam pump which they were placing on its foundation when, to my surprise, one of the pipe gang came in looking worried. I scented trouble. From what he said I gathered "Pipe no bueno." So I hurried back with him. We found the rest of the gang comfortably seated on the ground, smoking cigarettes. Each wore a look that I took to be serious and conscientious. "What's the matter?" I asked. Each "Mex" pointed mutely at the same spot.

I didn't dare laugh because I wanted to retain the good feeling that existed, but I believe I did smile. They had two bell ends butted up against each other just as the pipes had been accidentally thrown from the wagon in stringing them out, and as they didn't know how to make that kind of a joint they were helpless.

New York City.

N. G. NEAR.

Stresses in Circular Tubes

Dear Sir: The writer was very much interested in the article in your issue of June 14, 1913, on "Stress Analysis of Circular Tubes," by Mr. Björgulf Haukelid, and in your issue of Aug. 30, 1913, mention is made by Mr. C. W. Filkins of mathematical analyses by Professor Benjamin, William H. Searles, Edwin J. Fort and Prof. I. P. Church.

Perhaps it may be of interest to some of your readers to add that the analysis of the stresses in a closed circular ring under a vertical concentrated load at the top is given on page 220 of the "Lehrbuch der Ingenieur-Mechanik," by A. Ritter. The writer's copy of Dr. Ritter's treatise shows that it was published in 1885 by Baumgärtner's Buchhandlung, Leipzig. Further, another analysis may be found on page 341 of "Elasticität und Festigkeit," by C. Bach, published in 1894 by Julius Springer, Berlin.

The writer fully appreciates the amount of time which Mr. Haukelid must have devoted to the working out of the formulæ and results presented in his article in your issue of June 14, 1913, and engineers interested in this problem should welcome Mr. Haukelid's contribution.

The writer first became interested in the subject of stresses in a closed circular ring while connected with the construction of the water-filtration plant in Albany, N. Y., in 1897. What brought the matter especially to his attention was his desire to know what stresses and deformations would occur in a 48-in. riveted steel pipe under various conditions of loading. With the start obtained from Ritter's analysis of a closed ring under a single concentrated load, the writer worked up, during the winter of 1897, a number of formulæ designed to give the stresses in water pipes under different conditions of both loading and support; in fact, he even started to write a paper giving the results of his work and still has in his possession a typewritten manuscript of twenty-seven pages prepared at that time. Unfortunately, he has never seemed to find the opportunity since to complete the work then started.

The question of stresses in closed circular rings is one in which every waterworks engineer should be interested. Water pipes have generally been designed to withstand simply the internal pressure, but it is becoming recognized more and more every day that consideration must be given to the external loads, as well as the internal pressures, and that the stresses due to these loads must be taken into account, especially in pipes of large diameter.

An excellent opportunity is afforded for some one who has the time and inclination to work up a full series of formulæ which would be applicable to the design of water pipes under the various conditions of loading most likely to be met with in practice. Those interested in this subject will profit by reading Bulletin 31, February, 1913, of the Iowa State College of Agriculture and Mechanical Arts on "The Theory of Loads on Pipes in Ditches and Tests of Cement and Clay Drain Tile and Sewer Pipe," by A. Marston and A. O. Anderson.

JOHN H. GREGORY,

New York City.

Consulting Engineer.

Discretionary Clauses in Contracts

Dear Sir: In the issue of the Engineering Record, of Aug. 9, page 166, a letter appears from Mr. Guy H. Chase, of Fitchburg, Mass., a civil engineer, criticising the tendency of contracts to give a large measure of discretion to the engineer. This is commented on by an editorial on page 142, defending such discretionary provisions. My own experience as attorney for contractors has caused me to see the disadvantages both to owners and contractors in these provisions and to reach the conclusion that one of the most important problems in the legal side of engineering contracts is the adoption of a new form of contract which will place the parties upon a complete equality as to their legal rights. They violate the fundamental principles of law and justice.

The first legal essential of any contract is the meeting of the minds of the parties. This necessarily implies that two parties agree that a defined thing shall be done for a defined compensation. Just so far as the thing can be done and the compensation for it can be made certain an ideal contract is more closely approached. Where the thing to be done by one of the parties in consideration of a defined compensation is left largely to the discretion of the employee of one of these parties the contract deals with uncertainties and there is no meeting of the minds.

It has been well said by a distinguished judge in regard to one of these provisions:

"It in effect binds one party to abide as to every matter of fact, and as to every question of legal right, by the decision of the other party. Lord Coke said centuries ago that it becomes no man to be both judge and party in the same case."

Reported cases in the books can be readily found which illustrate the hardships to the contractors of depending upon the exercise of the discretion of the architect, engineer or other employee of the owner.

The Supreme Court of the United States had before it in 1879 a suit brought by a transportation contractor named Kihlberg for carrying Government stores in the Far West. Payment was to be made "in all cases according to the distance from the place of departure to that of delivery, the distance to be ascertained and fixed by the chief quartermaster of the district of New Mexico." There was no appeal from his decision, but the parties took it for granted that he would fairly and reasonably decide a mathematical question of no very great uncertainty. The contractor was dissatisfied with the distances fixed by the chief quartermaster and brought suit in the Court of Claims to be paid the rate fixed by the contract "according to the distance from the place of departure to that of delivery." The Court of Claims, upon full consideration of all the evidence, found that the chief quartermaster had fixed certain of the distances a number of miles shorter than the air line between the points. But the court declared as a matter of law that the contract made the findings of the chief quartermaster conclusive upon the parties and therefore refused to authorize payment to the contractor for what he had actually carried according to the actual distances, although he apparently solved all doubts in favor of the Government. The contractor appealed on this point of law to the Supreme Court of the United States, where the findings of fact of the lower court are not reviewable. The Supreme Court said that there was no fraud or bad faith upon the part of the chief quartermaster and that he had exercised the authority with an honest purpose to carry out the real intention of the parties and held that his mistaken decision was final

and could not be corrected. Thus the wrong originally done to the contractor by the chief quartermaster was perpetuated by the judgment of the highest court of the country. This illustrates very strikingly the danger to the contractor of vesting discretionary and uncontrolled power in an officer or employee of the owner. (*Kihlberg v. United States*, 97 U. S. 398.)

In the year 1900 a suit came before the Supreme Court of the United States between a contractor for improving the Ohio River at Louisville, Ky., and the United States. This contract provided that for any delay caused by "freshets, ice, or other force or violence of the elements, such additional time may be allowed as in the judgment of the engineer in charge shall be just and reasonable." An application was presented to the engineer officer for an extension of time and he refused to grant it because he said the contractors had in previous seasons failed to complete the work within the times agreed upon. The Court of Claims found as facts that the contractors had been delayed by violence of the elements for a longer time than had been allowed by the engineer officer and that the engineer had refused to exercise his judgment on the last application. They gave relief to the contractors upon the theory that they were entitled to the extension which the engineer officer had refused to make.

The Supreme Court said that it is competent for parties to make the decision of an engineer final and conclusive and said that rule was applicable in this case. Without disputing the facts found by the Court of Claims, the Supreme Court declared the contractors without any legal redress.

Here again the injustice done to the contractor and ascertained by the findings of a judicial tribunal was perpetuated by a decision of the highest court in the land. This presents another instance when the contract should have provided some method by which the contractor might have been relieved from the arbitrary and uncontrolled discretion of the engineer officer. (*United States v. Gleason*, 175 U. S. 588.)

In *Sweeney v. United States*, 109 U. S. 618, the contractor had agreed to build a brick wall, this to be inspected by an officer of the U. S. Army and to be received and become the property of the United States when that officer should certify that it is in all respects as contracted for. The wall was constructed and condemned and, without notice to the claimant, was taken down and reconstructed.

The contractor offered to prove that the wall was completed by him in compliance with the requirements of the contract. The Court of Claims refused to admit any evidence on that subject at all, holding that the inspection by the officer of the United States was the one test of the compliance of the wall with the contract. The Supreme Court sustained this decision on appeal.

These cases show that the courts uniformly uphold the clauses giving discretion to the engineer employed by the owner and illustrate the grave danger that every contractor runs in entering into such contracts.

The effect of such clauses, when carried to an extreme, is well stated by Chief Justice Nott, of the Court of Claims, now retired, who is the only living judicial appointee of President Lincoln, in these memorable words:

"If the full intent and effect be given to this provision which the defendants now ascribe to it, the contractors might as well have written an agreement on half of a sheet of paper, binding themselves to perform whatever work and furnish whatever material the chief of the bureau might require, and accept therefor

whatever remuneration the Secretary of the Treasury might be pleased to give them." (*Barlow v. United States*, 544.)

It may be added that the Supreme Court gave to this contract the very intent and effect above stated. (*United States v. Barlow*, 184 United States 123.)

The hardships of the unnecessary multiplication of discretionary clauses was recognized by the American Institute of Architects in its circular of advice of December, 1909, where it says that the architect should never "attempt to shirk responsibility by indefinite clauses in the contract or specifications."

Competent engineers who have studied the subject with care state that proper foresight will greatly reduce, and almost entirely eliminate, the use of these clauses. In many cases they are inserted because no sufficient preliminary investigation has been made to remove uncertainties—the owner or engineer who draws the specifications preferring to commit the contractor to an indefinite obligation rather than to make a sufficient examination in advance to decide what work must be done. A prominent officer of the United States once said to the writer that he preferred to have these discretionary clauses because in that way he held the contractor in his power. When asked how the contractor should be sure of justice, he replied that he was always careful to deal fairly with contractors. It is a rather significant fact that this particular officer had a reputation among contractors as dealing with them with the utmost stringency when once he had them in his power.

In a paper read by Major Cassius E. Gillette, of Philadelphia, formerly of the Engineer Corps of the U. S. Army, printed in the "Journal" of the American Society of Engineering Contractors, February, 1912, he says:

"No bid should be called for where the award of the contract or the details of its execution are to depend upon the discretion of any official or his personal satisfaction or dissatisfaction. All such discretion and other emotions should be exercised in advance of the opening of bids, or exactly how they will be applied should be specified in detail in advance of such opening."

The interest of the owner are not ultimately served by the use of such discretionary clauses. Every risk which the contractor runs makes his bid uncertain and consequently requires the addition of a percentage for the uncertainty. If specifications are so drawn that the contractor knows exactly what he is to bid upon, he can figure closely. If discretion is lodged so generously in the engineer that the contractor does not know what work he may be called upon to do, he bids higher. The Court of Claims well declared on one occasion:

"A policy which precludes legal redress will drive every prudent and responsible contractor out of the field of competition."

The conclusion seems inevitable that it is of equal benefit to owners and to contractors that the discretionary clauses should be limited to the minimum and that where they occur they should not vest an arbitrary and uncontrolled discretion in the employee of the owner, but that his judgment should be subject to revision by a fair and impartial tribunal.

WILLIAM B. KING,

Washington, D. C. Bar of Court of Claims.

ANTHRACITE COAL SHIPMENTS in the United States may exceed 70,000,000 tons during 1913 if the gain over the corresponding shipments for 1911 persists. During the first seven months of 1913 shipments amounted to 40,000,000 tons.